FINAL REPORT

ENERGY ENGINEERING ANALYSIS PROGRAM

for

YUMA PROVING GROUND
YUMA, ARIZONA

EXECUTIVE SUMMARY

Contract No. DACA05-81-C-0129

Submitted to:

U.S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, California 95814

By:

Energy Management Consultants, Inc.
672 S. Lafayette Park Place, No. 38
Los Angeles, California 90057

6 DECEMBER 1982

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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1.Ø. INTRODUCTION

1.1. PURPOSE

In compliance with the United States Army Facilities Energy Plan and Executive Order No. 12ØØ3, Energy Management Consultants, Inc., (EMC) began work on 8 June 1981 to prepare Increments A, B, and G, for the Energy Engineering Analysis Program (EEAP) at Yuma Proving Ground (YPG), Arizona.

The purpose of this study (See Section 4.1 of the General Scope of Work in Main Appendix A) is to provide the Army with a "Coordinated Basewide Energy Study", determination and analysis of Energy Conservation Investment Program (ECIP) projects, and development of DD Forms 1391, PDB's, and other necessary back-up information to support Energy Conservation Investment Program (ECIP) projects scheduled for FY '86 at Yuma Proving Ground.

1.2. SCOPE

The EEAP for YPG follows the instructions stated in the General Scope of Work (revised 8 January 1982) and the Detailed Scope of Work (Appendix A) for Yuma Proving Ground. The following items were funded under the existing contract:

- o Increments A - Energy Conservation investigations for buildings and processes;
- o Increment B - Energy Conservation investigations of utilities and energy distribution systems, Energy Monitoring and Control Systems (EMCS), local use of available waste fuels in existing energy plants;
- o Increment G - Projects identified in Increments A and B that do not qualify under ECIP criteria; and
- o Increment F - Facilities Engineer conservation measures. Results of the detailed energy analysis, including basewide energy use profiles, individual building energy consumption, ECIP project analysis and recommendations, are presented in this Executive Summary.

1.3. OVERVIEW

EMC spent over two months at YPG during the summer of 1981 collecting field data which was used throughout the

analysis. Every building was studied to determine energy consumption in five major categories: (1) space heating, (2) space cooling, (3) lighting, (4) domestic hot water heating, and (5) other miscellaneous equipment loads. Energy use for similar types of buildings were compared and adjustments were made so that predictions for individual building energy consumption together with other non-building and family housing energy uses would equal total basewide energy consumption.

Potential energy conservation opportunities (ECOs) were identified from field investigations and checklists developed by EMC over the years from previous energy audits. Potential projects include but are not limited to those items listed in Appendix C of the Contract Scope of Work.

The analysis of an Energy Monitoring Control System (EMCS) as specified in Section 4.2.2.4 of the Scope of Work includes two alternatives for expanding the existing EMCS capabilities:

1. Upgrading of existing EMCS (radio communication)

2. Installation of a new EMCS (existing telephone line communication)

Results for <u>all</u> projects which were identified and studied throughout the analysis and which either meet ECIP criteria or are included as Increment G and F projects were separated and documented in accordance with the guidelines stated in the Contract Scope of Work (See Section 9.4 and 9.5). Complete DD 1391 and PDB forms for ECIP and Increment G projects are presented in a separate document.

The Final Submittal is presented in eight volumes of text:

- Executive Summary. Summary of all work accomplished in Increments A, B, F, and G of the EEAP for Yuma Proving Ground.

- Volume I. Main Report. Narrative description of the work including procedures, analysis results and summary.

- Volume II. Main Appendix. Necessary back-up information referenced throughout the main report.

- Volume III. Complete DD Forms 1391 and PDB's for 10 selected projects.

- Volume IV. DD 1391 cover sheets for remaining ECIP and Increment G projects.

- Volume V. Increment F Report. Narrative description and results of work performed as part of Increment F.

- Volume VI. Increment F, Appendix A. All energy calculations, cost estimates, and descriptions for Increment F projects on a per building basis.

- Volume VII. Increment F, Appendix B. Expendable equipment specifications and manufacturers' data.

1.4. SUMMARY OF RESULTS

Results of this EEAP for YPG have revealed many interesting facts about the operation, use, and general condition of buildings and family housing units as they relate to energy consumption. Two months of field work and subsequent visits to the site have allowed us to observe YPG during both the summer and winter operating seasons.

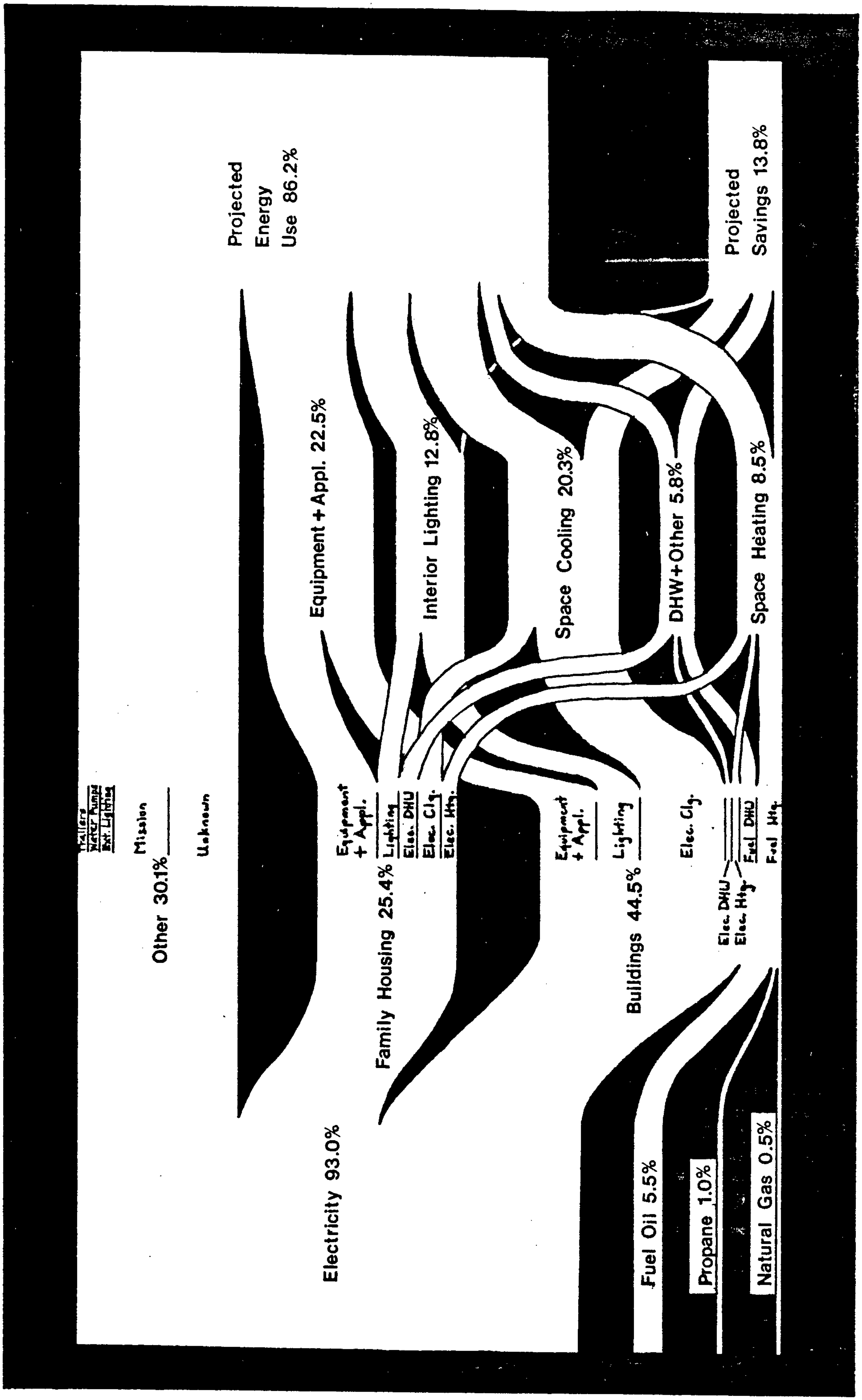
FE is well informed about past and current energy consumption patterns at YPG, and as a result, has been able to identify and implement measures in an attempt to conserve energy. Discussions with YPG personnel show good results. They should be commended for their success in this regard.

Referring to the YPG basewide energy flow diagram (Exhibit 1), YPG consumes on the average 338,200 MMBTU/yr based on data for 1979, 1980, and 1981. Approximately 93% of that energy is electricity. The other 7% includes fuel oil, propane, and natural gas. Of this total, approximately 236,200 MMBTU are consumed specifically by buildings and family housing. The remaining 102,000 MMBTU are consumed by non-building related activities such as mission testing, exterior lighting, water pumping, mobile trailers, and line loss.

Army energy goals specify a 20% reduction of energy use for buildings and family housing units by 1985. During the base year of 1975, there were 1,150,250 gross square feet of energy consuming buildings and an annual basewide energy consumption of 297,654 MMBTU (12% less than 1979 - 1981 average consumption). This represents 207,880 MMBTU for buildings (including family housing) and 89,775 MMBTU for nonbuilding uses.

After accounting for the additions and deletions of buildings since 1975, there is currently a total of

Exhibit 1. YPG ENERGY FLOW DIAGRAM



Note: Basewide total energy consumption is 338,200 MMBTU (avg. for 1979, 1980, & 1981).

1,245,675 gross square feet of energy consuming buildings and family housing (an increase of 8%). The table below summarizes the 1975 and current 3 year average of gross energy use per square foot of floor area and the necessary reduction in energy use which must be achieved to meet the 1985 energy goal:

FiscalYear	KBTU/sf	Total Building and Family Housing Energy Load (MMBTU)	% Change
1975 base	181	207,880	baseline
1979-1981 average	190*	236,200	+5%
1985 goal	145*	180,625	-20%
Required reduction in energy use to meet energy goals	45*	55,575	-24%**

* Based on current square footage

** Savings that must be achieved to meet 1985 goal based on average energy use for the years 1979 through 1981

Exhibit 2 summarizes all ECIP and Increment G projects. This summary prioritizes and separates the ten projects that YPG has selected for detailed justification and PDB's (which are documented and included as a Volume III) from the remaining ECIP and Increment G projects (whose DD1391 cover sheets are included as a Volume IV). Exhibit 3 summarizes the Increment F projects analyzed in this report. Except for the fact that all ECIP projects are programmed for FY'86 (which is beyond the 1985 target year for 20% energy reductions), the ECIP, Increment G and Increment F projects analyzed will save a total of 52,050 MMBTU/year which is slightly less than the required 20% energy reduction necessary to meet Army energy goals. It is anticipated that after completing the other EEAP Increments (particularly C), enough projects will be developed to exceed the 20% energy reduction. The need for implementating Increment C projects seems, therefore, paramount so that YPG can meet the 1985 goal for reduction of energy use.

Exhibit 2. SUMMARY OF ECIP AND INCREMENT G PROJECTS

COMPLETE DD 1391 & PDB FORMS FOR 10 PROJECTS

Project Title	Energy Savings (MMBTU)	Project Cost ($)	E/C Ratio	B/C Ratio	Simple Amortization (years)	Increment
ECIP Project to Install New Lighting Systems	2,660	149,433	17.8	1.98	4.8	A
ECIP Project to Improve Thermal Performance of Roofs	2,656	149,739	17.7	2.2	6.4	A
ECIP Project to Install Night Setback Thermostats for Family Housing	1,930	121,206	16.0	1.1	10.6	A
ECIP Project to Install Solar DHW & Conserve Water	2,464	164,676	15.0	4.5	4.3	A
ECIP Project to Install Blown-In Insulation on Exterior Walls	3,226	234,976	13.7	2.6	5.8	A
Project to Upgrade Existing EMCS	9,775	70,945	137.9	16.9	0.6	G
Project to Install Solar DHW and Conserve Water in Family Housing	10,089	891,093	11.3	0.86	19.8	G
Project to Install Surface Applied Insulation on Exterior Walls	3,723	494,478	7.5	2.4	6.8	G
Project to Install Exterior Roof Insulation in Family Housing	5,519	801,190	6.9	0.77	20.1	G
Project to Install New Lighting Systems	82	19,851	4.1	1.5	5.4	G

ECIP AND INCREMENT G DD 1391 COVER SHEETS

Project Title	Energy Savings (MMBTU)	Project Cost($)	E/C Ratio	B/C Ratio	Simple Amortization (years)	Increment
ECIP Project to Install New EMCS (telephone line communication)	9,775	584,913	16.7	2.0	5.1	B
Project to Install Weatherstripping	50	2,285	22.0	4.5	3.4	G
Project to Install Movable Insulation for Windows	1,498	120,202	12.5	1.8	6.2	G
Project to Install Sunscreens for Windows	497	78,756	6.3	.66	15.3	G
Project to Install Wall Insulation in Family Housing	5,868	1,580,533	3.7	0.4	40.1	G
Project to Install Solar Energy DHW Heating Systems	80	29,404	2.7	0.48	50.8	G
Project to Install Exterior Roof Insulation	277	103,020	2.7	0.26	49.1	G
Project to Install Blown-In Insulation on Exterior Walls	213	89,834	2.4	0.34	42.5	G
Project to Apply Reflective Roof Coating	138	56,935	2.4	-0.01	213.2	G

Exhibit 3. SUMMARY OF INCREMENT F PROJECTS

INCREMENT F PROJECT DATA BASE

NATURE OF PROJECT	BLDG. NO.	ENERGY SAVINGS PER YEAR	DOLLAR SAVINGS PER YEAR	COST OF MATERIAL	TRADE REQUIRED	HOURS REQ'D	TOTAL COST	ENERGY TO COST RATIO	SIMPLE PAYBACK
IMPROVE HVAC CONTROLS	1100	592.38	2399	220	ELECTRICIAN	10	427	5622.0	0.17
REDUCE DHW SUPPLY TEMPERATURE	506	62.92	620	0	PLUMBER	1	18	3550.0	0.02
REDUCE DHW SUPPLY TEMPERATURE	1004	53.00	525	0	PLUMBER	1	18	2995.0	0.03
INSTALL AUTOMATIC LIGHTING CONTROLS	2105	56.90	230	130	ELECTRICIAN	3	190	1094.2	0.82
INSTALL AUTOMATIC VENT DAMPER	506	262.00	2590	330	SHEET MTL WKR	4	415	634.1	0.16
INSTALL AUTOMATIC LIGHTING CONTROLS	5	16.30	66	28	ELECTRICIAN	1	38	428.9	0.57
INSULATE REFRIGERANT SUCTION LINES	106	29.40	120	25	PLUMBER	4	100	295.9	0.83
ISOLATE BUILDING ZONE	505	92.80	375	140	CARPENTER/AC	13	350	265.0	0.93
INSULATE REFRIGERANT SUCTION LINES	105	19.27	78	18	PLUMBER	4	75	248.1	0.96
ISOLATE BUILDING ZONE	500	89.60	520	155	CARPENTER/AC	13	380	235.0	0.73
INSTALL AUTOMATIC VENT DAMPER	105	47.23	465	165	SHEET MTL WKR	2	205	228.6	0.44
INSTALL AUTOMATIC VENT DAMPER	518	36.06	355	165	SHEET MTL WKR	2	205	174.5	0.57
INSTALL AUTOMATIC LIGHTING CONTROLS	505	24.50	100	110	ELECTRICIAN	2	150	162.0	1.50
INSTALL AUTOMATIC VENT DAMPER	1000	30.75	305	165	SHEET MTL WKR	2	205	148.8	0.67
INSTALL AUTOMATIC VENT DAMPER	1004	51.34	505	330	SHEET MTL WKR	4	415	124.2	0.82
ISOLATE BUILDING ZONE	307	395.80	2160	2230	CARPENTER/AC	63	3300	120.0	1.52
REWIRE LIGHT SWITCHING	3520	58.30	235	205	ELECTRICIAN	15	500	117.3	2.12
INSTALL AUTOMATIC VENT DAMPER	1003	22.90	225	165	SHEET MTL WKR	2	205	110.9	0.91
INSULATE REFRIGERANT SUCTION LINES	101	4.22	17	7	PLUMBER	2	42	100.4	2.47
INSTALL DAYLIGHTING PANELS	2075	137.70	560	176	CARPENTER	80	1420	97.2	2.53
INSTALL AUTOMATIC VENT DAMPER	1100	19.85	195	165	SHEET MTL WKR	2	205	96.1	1.05
INSTALL AUTOMATIC VENT DAMPER	120	18.50	182	165	SHEET MTL WKR	2	205	89.4	1.12
REWIRE LIGHT SWITCHING	307	21.20	85	120	ELECTRICIAN	9	290	73.4	3.41
INSTALL A/C PRECOOLER	990	523.30	2119	6875	HVAC MECHANIC	30	7500	69.7	3.53
REWIRE LIGHT SWITCHING	3490	45.50	185	275	ELECTRICIAN	20	675	67.4	3.64
REWIRE LIGHT SWITCHING	304	33.80	137	210	ELECTRICIAN	15	510	66.2	3.72
INSULATE BOILER CASINGS	1004	25.50	250	170	CARPENTER	15	400	63.8	1.60
INSTALL AUTOMATIC VENT DAMPER	1001	12.60	125	165	SHEET MTL WKR	2	205	60.9	1.64
INSULATE REFRIGERANT SUCTION LINES	504	0.50	2	1	PLUMBER	1	9	54.6	4.50
INSULATE BOILER CASINGS	1003	12.14	120	113	CARPENTER	10	265	45.8	2.20
INSULATE BOILER CASINGS	506	97.60	965	930	CARPENTER	82	2200	44.4	2.27
REWIRE LIGHT SWITCHING	501	49.81	200	462	ELECTRICIAN	33	1135	44.1	5.67
REWIRE LIGHT SWITCHING	305	14.70	60	140	ELECTRICIAN	10	340	43.2	5.66
REDUCE EXHAUST FAN USE	506	93.70	390	110	ELECTRICIAN	100	2180	43.0	5.58
INSULATE AIR HANDLER	506	169.80	929	1100	CARPENTER	150	4219	40.3	4.54
INSULATE REFRIGERANT SUCTION LINES	1000	0.86	3	6	PLUMBER	1	23	36.8	7.66
INSULATE BOILER CASINGS	120	9.96	98	123	CARPENTER	11	291	34.2	2.96
INSULATE BOILER CASINGS	518	6.83	67	85	CARPENTER	7	200	34.2	2.98
INSULATE BOILER CASINGS	3566	6.83	67	84	CARPENTER	7	200	34.2	2.98
REWIRE LIGHT SWITCHING	300	26.20	106	325	ELECTRICIAN	23	795	33.0	7.50
REWIRE LIGHT SWITCHING	503	39.20	160	530	ELECTRICIAN	38	1305	30.1	8.15
INSULATE REFRIGERANT SUCTION LINES	2090	0.88	4	8	PLUMBER	1	35	25.0	8.75
INSULATE REFRIGERANT SUCTION LINES	2096	3.90	16	37	PLUMBER	7	155	25.0	9.68
INSULATE DUCTWORK	712	4.00	19	59	CARPENTER	7	161	24.8	8.47
REPLACE BALLASTS	990	21.10	85	340	ELECTRICIAN	26	875	24.1	10.29
INSULATE AIR HANDLER	232	5.02	29	110	CARPENTER	7	213	23.6	7.34
REPLACE BALLASTS	304	12.90	55	215	ELECTRICIAN	16	555	23.3	10.09
INSTALL AUTOMATIC VENT DAMPER	232	4.70	45	165	SHEET MTL WKR	2	205	22.7	4.55

Exhibit 3. (cont'd)

INCREMENT F PROJECT DATA BASE

NATURE OF PROJECT	BLDG. NO.	ENERGY SAVINGS PER YEAR	DOLLAR SAVINGS PER YEAR	COST OF MATERIAL	TRADE REQUIRED	HOURS REQ'D	TOTAL COST	ENERGY TO COST RATIO	SIMPLE PAYBACK
INSULATE AIR HANDLER	506	61.90	331	737	CARPENTER	100	2816	22.0	8.50
REWIRE LIGHT SWITCHING	302	22.40	90	415	ELECTRICIAN	30	1020	21.9	11.33
REPLACE BALLASTS	105	10.30	42	195	ELECTRICIAN	15	505	20.4	12.02
INSULATE AIR HANDLER	1004	11.66	73	343	CARPENTER	17	598	19.5	8.19
INSULATE AIR HANDLERS	714	4.04	23	55	CARPENTER	10	209	19.3	9.08
INSTALL INSULATED ROLLDOOR	3493	48.30	220	2220	CARPENTER	18	2500	19.3	11.36
REPLACE BALLASTS	503	10.70	45	220	ELECTRICIAN	17	575	18.7	12.77
REPLACE BALLASTS	501	11.00	45	230	ELECTRICIAN	18	590	18.7	13.11
INSULATE AIR HANDLER	301	2.90	16	55	CARPENTER	5	159	18.2	9.93
REPLACE BALLASTS	3520	17.60	70	380	ELECTRICIAN	29	975	18.0	13.92
INSTALL HIGH EFFICIENCY MOTORS	3523	3.50	14	165	ELECTRICIAN	2	205	17.2	14.64
SHUTDOWN BOILER / NEW DHW HEATER	518	10.02	100	470	PLUMBER	8	615	16.3	6.15
INSULATE DUCTWORK	701	1.80	9	41	CARPENTER	5	113	15.9	12.55
REPLACE BALLASTS	303	13.14	55	320	ELECTRICIAN	25	825	15.9	15.00
REPLACE BALLASTS	3519	24.13	100	585	ELECTRICIAN	45	1515	15.9	15.15
REPLACE BALLASTS	714	17.70	72	430	ELECTRICIAN	33	1110	15.9	15.41
REPLACE BALLASTS	205	8.60	35	210	ELECTRICIAN	16	540	15.9	15.42
REPLACE BALLASTS	2	77.00	312	1870	ELECTRICIAN	145	4835	15.9	15.49
REPLACE BALLASTS	402	9.90	40	240	ELECTRICIAN	18	625	15.9	15.62
REPLACE BALLASTS	702	13.95	56	340	ELECTRICIAN	26	875	15.9	15.62
REPLACE BALLASTS	300	7.50	30	182	ELECTRICIAN	14	470	15.9	15.66
REPLACE BALLASTS	1220	3.75	15	90	ELECTRICIAN	7	235	15.9	15.66
REPLACE BALLASTS	2100	30.00	120	730	ELECTRICIAN	56	1890	15.9	15.75
REPLACE BALLASTS	306	12.90	50	315	ELECTRICIAN	24	810	15.8	16.20
REPLACE BALLASTS	701	2.50	10	65	ELECTRICIAN	5	170	14.9	17.00
INSULATE AIR HANDLER	2000	2.70	14	83	CARPENTER	5	186	14.5	13.28
INSULATE AIR HANDLER	2	3.00	24	110	CARPENTER	10	212	14.1	8.83
REPLACE BALLASTS	302	8.50	34	235	ELECTRICIAN	18	605	13.9	17.79
REPLACE BALLASTS	3490	16.50	66	455	ELECTRICIAN	35	1180	13.9	17.87
REPLACE BALLASTS	3021	16.40	65	455	ELECTRICIAN	35	1180	13.9	18.15
INSTALL INSULATED ROLLDOOR	2104	12.20	61	770	CARPENTER	8	890	13.8	14.59
REPLACE BALLASTS	2075	13.90	56	545	ELECTRICIAN	24	1040	13.3	18.57
REPLACE BALLASTS	2700	6.30	25	180	ELECTRICIAN	14	470	13.3	18.80
INSTALL INSULATED ROLLDOOR	3520	12.90	72	925	CARPENTER	9	1050	12.3	14.58
INSULATE REFRIGERANT SUCTION LINES	120	0.27	1	6	PLUMBER	1	25	11.7	25.00
INSTALL HIGH EFFICIENCY MOTORS	2104	2.30	9	165	ELECTRICIAN	2	205	11.3	22.77
INSTALL INSULATED ROLLDOOR	3022	30.94	180	2590	CARPENTER	20	2900	10.7	16.11
IMPROVE AIR DISTRIBUTION	3490	606.00	3555	36300	SHT MTL/ELECT	1000	57020	10.6	16.03
COOLING EQUIPMENT REPLACEMENT	304	22.53	91	1650	HVAC MECHANIC	25	2167	10.4	23.81
REPLACE BALLASTS	2500	6.06	25	235	ELECTRICIAN	18	605	10.0	24.20
REPLACE BALLASTS	307	4.70	20	180	ELECTRICIAN	14	470	9.9	23.50
REPLACE BALLASTS	2096	7.90	32	305	ELECTRICIAN	24	790	9.9	24.68
REPLACE BALLASTS	2090	10.10	40	390	ELECTRICIAN	30	1010	9.9	25.25
REPLACE BALLASTS	3523	19.50	80	820	ELECTRICIAN	63	2120	9.2	26.50
INSTALL PROGRAMABLE CONTROLLER	506	505.00	2045	32395	ELECTRICIAN	1100	55020	9.2	26.90
COOLING EQUIPMENT REPLACEMENT	3	16.52	67	1320	HVAC MECHANIC	25	1837	9.0	27.41
COOLING EQUIPMENT REPLACEMENT	2710	17.70	72	1430	HVAC MECHANIC	30	2050	8.6	28.47
IMPROVE WINDOW SHADING	3519	7.40	35	790	CARPENTER	10	940	7.9	26.85

Exhibit 3. (cont'd)

INCREMENT F PROJECT DATA BASE

NATURE OF PROJECT	BLDG. NO.	ENERGY SAVINGS PER YEAR	DOLLAR SAVINGS PER YEAR	COST OF MATERIAL	TRADE REQUIRED	HOURS REQ'D	TOTAL COST	ENERGY TO COST RATIO	SIMPLE PAYBACK
REPLACE BALLASTS	305	6.20	25	300	ELECTRICIAN	23	775	7.9	31.00
IMPROVE WINDOW SHADING	451	36.10	160	4390	CARPENTER	52	5190	7.0	32.43
IMPROVE WINDOW SHADING	701	3.60	16	456	CARPENTER	6	540	6.7	33.75
INSTALL HIGH EFFICIENCY MOTORS	3490	1.40	6	178	ELECTRICIAN	2	220	6.4	36.66
INSTALL HIGH EFFICIENCY MOTORS	702	2.10	9	270	ELECTRICIAN	3	330	6.3	36.66
INSTALL HIGH EFFICIENCY MOTORS	504	3.90	16	505	ELECTRICIAN	6	630	6.2	39.37
COOLING EQUIPMENT REPLACEMENT	101	11.26	46	1430	HVAC MECHANIC	25	1947	5.8	42.32
INSTALL HIGH EFFICIENCY MOTORS	3490	4.30	17	585	ELECTRICIAN	9	770	5.6	45.29
COOLING EQUIPMENT REPLACEMENT	302	20.27	82	3300	HVAC MECHANIC	25	3817	5.3	46.54
INSTALL HIGH EFFICIENCY MOTORS	3493	1.00	4	165	ELECTRICIAN	2	205	4.9	51.25
REPLACE BALLASTS	309	2.20	10	180	ELECTRICIAN	14	470	4.7	47.00
COOLING EQUIPMENT REPLACEMENT	1001	28.16	114	4400	HVAC MECHANIC	150	7500	3.7	65.78
COOLING EQUIPMENT REPLACEMENT	518	23.28	94	3300	HVAC MECHANIC	150	6402	3.6	68.10
REPLACE BALLASTS	5	4.30	17	520	ELECTRICIAN	40	1350	3.2	79.41
SHUTDOWN BOILER / NEW DHW HEATER	105	1.34	15	295	PLUMBER	8	435	3.1	29.00
COOLING EQUIPMENT REPLACEMENT	2210	11.64	47	2200	HVAC MECHANIC	75	3750	3.1	79.78
INSTALL SUPPLY AIR BALANCING DAMPER	205	0.00	0	79	SHEET MTL/DRY	4	150	0.0	0.00
INSTALL SUPPLY AIR DUCTS & REGISTERS	215	0.00	0	949	SHEET MTL WKR	49	1966	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	306	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	307	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	308	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	309	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	500	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	501	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INCREASE RETURN AIR DUCT SIZE	503	0.00	0	1265	SHEET MTL WKR	205	5527	0.0	0.00
INSTALL NEW DUCTWORK	2700	0.00	0	440	SHEET MTL WKR	60	1687	0.0	0.00
IMPROVE RETURN AIR SYSTEM	6071	0.00	0	2200	HVAC MECHANIC	300	8401	0.0	0.00
IMPROVE HVAC CONTROLS	120	0.00	0	220	HVAC MECHANIC	10	427	0.0	0.00
IMPROVE HVAC CONTROLS	504	0.00	0	2200	HVAC MECHANIC	10	2407	0.0	0.00
IMPROVE HVAC CONTROLS	1003	0.00	0	550	HVAC MECHANIC	20	963	0.0	0.00
IMPROVE HVAC CONTROLS	1004	0.00	0	550	HVAC MECHANIC	20	963	0.0	0.00
IMPROVE HVAC CONTROLS	6004	0.00	0	550	HVAC MECHANIC	50	1584	0.0	0.00
REPAIR FLEX CONNECTOR	215	0.00	0	1	SHEET MTL WKR	1	22	0.0	0.00
REPAIR DUCT INSULATION	402	0.00	0	1	CARPENTER	1	17	0.0	0.00
REPAIR FLEX CONNECTORS	451	0.00	0	3	SHEET MTL WKR	2	45	0.0	0.00
REPAIR FLEX CONNECTORS	530	0.00	0	5	SHEET MTL WKR	3	67	0.0	0.00
REPAIR AIR HANDLER LEAKS	1001	0.00	0	11	SHEET MTL WKR	1	32	0.0	0.00
REPAIR AIR HANDLER LEAKS	2100	0.00	0	11	SHEET MTL WKR	1	32	0.0	0.00
** TOTAL **									
		5311.81	28468				284544		

Note: Energy Savings are expressed in KBTU units;
Cost of Material and Total Cost are expressed in Dollars ($);
Simple Payback is expressed in Years.

2.Ø. INSTALLATION ENERGY PROFILE

2.1. GENERAL DISCUSSION

The complete energy use profile for YPG under designated operating procedures and conditions is presented in this section. Exhibit 1 (page 4), the Basewide Energy Flow Diagram, shows graphically the various load components and end uses relative to the four energy sources delivered to YPG.

The procedure used for determining the various load components included computer analysis of every building and family housing type using the PASS-ONE and PEAKLOAD computer programs. These programs provided a breakdown for buildings and family housing in percent of end use loads for space heating and cooling, lights, appliances and equipment, and domestic water heating for both electricity and fossil fuels. At the same time, non-building loads for exterior lighting, water pumping, mobile trailers, line losses, and mission testing were developed.

The sum of these three loads ("buildings", "family housing", and "non-building loads") constitutes the known energy uses at YPG (with the exception, of course, of mission activities that consume other types of fuels).

These calculated energy use numbers were compared to historical monthly utility data for the past three years and adjusted accordingly based on seasonal fluctuations in actual consumption that result from actual climatic conditions.

The following discussion is based upon the results, procedures, verifications, and adjustments that resulted from the development of this YPG base wide energy use profile.

2.2. YPG ENERGY LOAD PROFILE

The energy use data and results of our analysis were graphed and charted. Exhibit 4 shows the monthly electrical and combined fuel use (fuel oil, propane, and natural gas). Exhibit 5 shows the monthly consumption of each of the three fossil fuels and their relative sizes, and Exhibit 6 summarizes energy consumption from 1975 to the present.

This energy use data and the analysis procedure discussed above provide a gross breakdown of energy usage at YPG (See Exhibit 7 for the various categories).

Exhibit 4. MONTHLY ELECTRICAL AND COMBINED FUELS (FUEL OIL, PROPANE, NATURAL GAS) CONSUMPTION

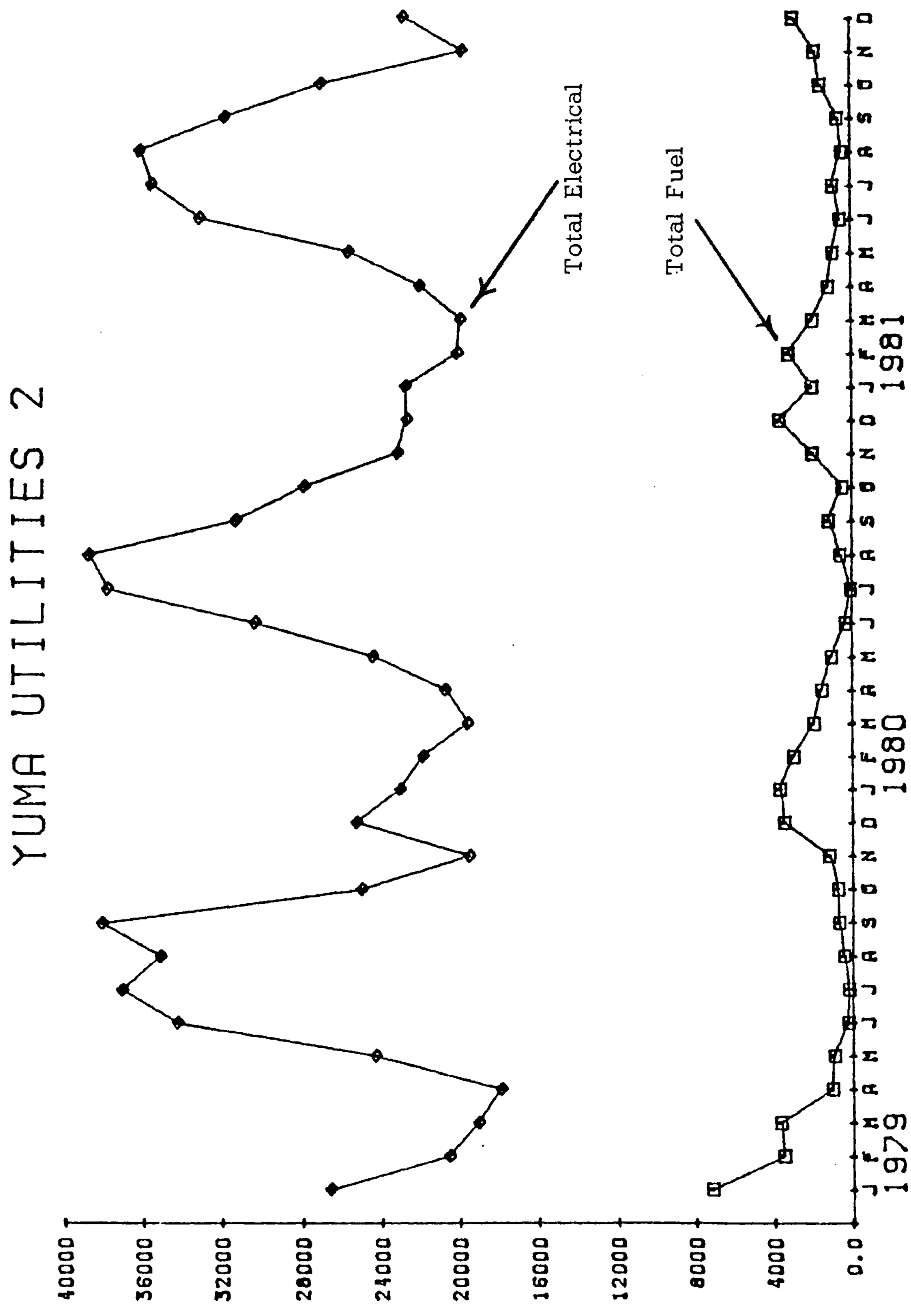


Exhibit 5 . MONTHLY CONSUMPTION OF FUEL OIL, PROPANE, & NATURAL GAS

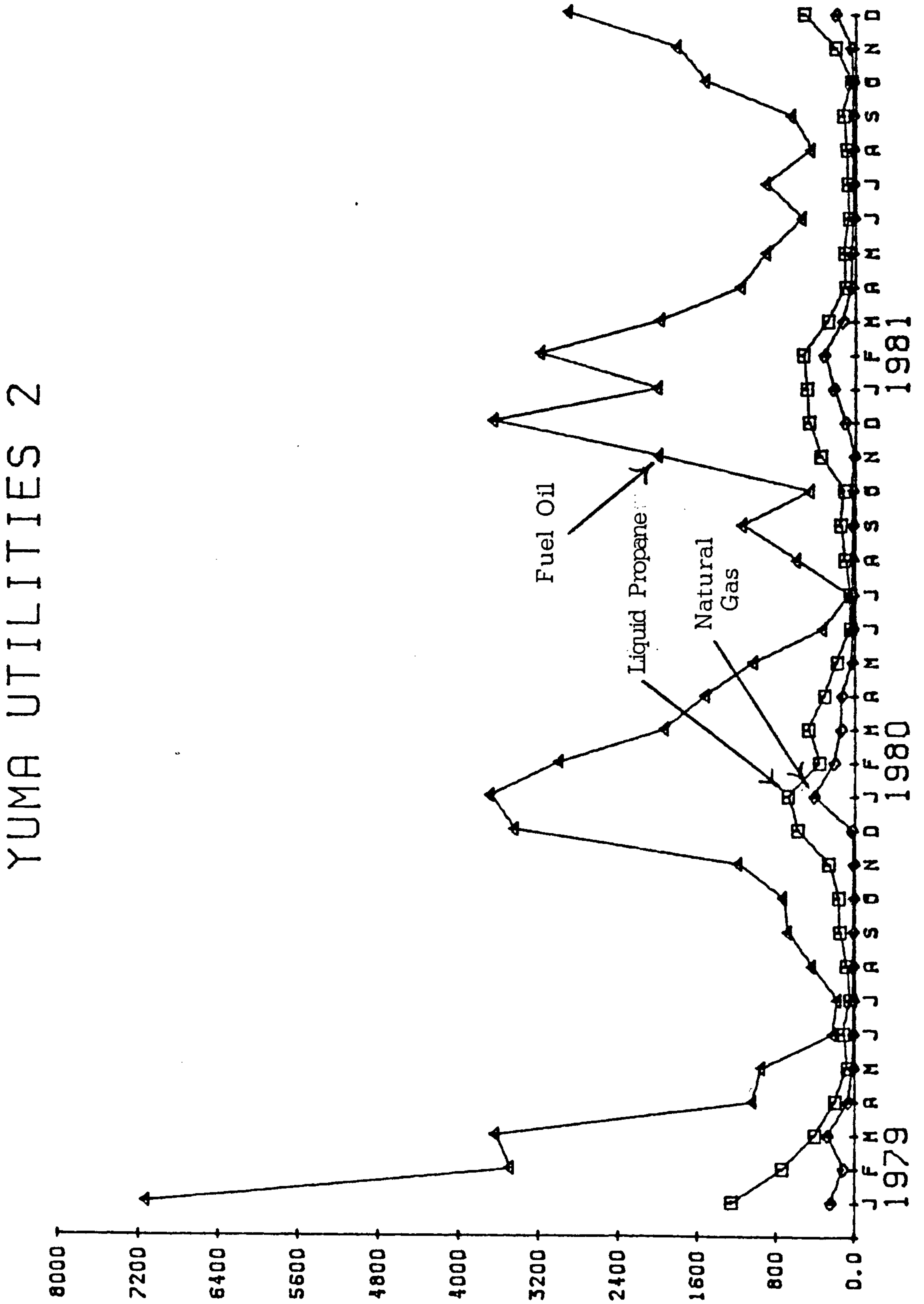


Exhibit 6. HISTORICAL ENERGY USAGE

Year	Electricity (MMBTU)	Fuel Oil (MMBTU)	Propane (MMBTU)	Natural Gas (MMBTU)	Total (MMBTU)	Total Cost ($)
1975	275,850	12,485	2001	258	297,654	220,000
1976	284,900	20,185	3044	260	308,389	227,000
1977	287,100	19,390	2811	178	309,479	298,000
1978	287,700	16,985	2655	218	307,558	323,500
1979	321,300	18,680	3249	742	343,971	345,500
1980	319,750	16,090	2119	1105	339,064	437,900
1981	313,650	15,330	1555	993	331,542	480,900

3 Year Average
used for Analysis: 338,200

Note: Predicted energy costs for 1982 through 2000 will be provided with the Increment F submittal, and will include additional energy requirements resulting from new construction.

Exhibit 7a. ENERGY CONSUMPTION BY USAGE AND CATEGORY

Category	Buildings (MMBTU)	Family Housing (MMBTU)	Non-Bldg. & Housing (MMBTU)	Total (MMBTU)	Percentage Percentage (%)
Heating	18,955	9,690	--	28,645	8.5
Cooling	53,020	15,450	--	68,470	20.3
Baseline*	78,505	60,580	57,425	196,510	58.1
Unknown	--	--	44,575	44,575	13.1
Total	150,480**	85,720	102,000	338,200	100.0

Exhibit 7b. ENERGY CONSUMPTION BY FUEL SOURCE AND USAGE

Energy Source	Baseline* (MMBTU)	Heating (MMBTU)	Cooling (MMBTU)	Unknown (MMBTU)	Total (MMBTU)	Percentage (%)
Electricity	188,355	13,125	68,470	44,575	314,525	93
Fuel Oil	6,510	12,090	--	--	18,600	5.5
Propane	1,350	2,030	--	--	3,380	1
Natural Gas	200	1,490	--	--	1,690	.5
Total	196,415	28,735	68,470	44,575	338,200	100

* All Energy use (including buildings, family housing, and non-building) other than for HVAC

** 150,480 MMBTU total energy consumption includes 5,500 MMBTU not shown in Exhibit 1. This additional energy consumption includes hospital and dental equipment, boiler startup and other medical related loads.

Energy consumption for all buildings is presented in Exhibit 8 and includes the individual load components for each building. Exhibit 9 summarizes the 10 largest energy consuming buildings at YPG. Together these buildings consume 75,562 MMBTU/year, or 33% of the total building/family housing energy consumption. Similar results are also presented for family housing in Exhibit 10.

All non-building energy loads were included to provide a complete base wide energy load profile. Interviews with various YPG personnel provided the information that was used to define these energy loads:

o	Exterior Lighting	-	7,000
o	Water & Sewage Pumping	-	7,000
o	Temporary Trailers	-	2,800
o	Mission Testing	-	34,800
o	Line Losses	-	6,400
	Total	-	58,000 MMBTU

The above loads are assumed to be accurate to within 10%, except perhaps Mission Testing. Since there is no submetering of this load and historical records are not available to verify this activity, an accuracy of only 20% can be assumed for Mission Testing.

Exhibit 8. YPG BUILDING ENERGY USE REPORT

Y.P.G. BUILDING ENERGY USE REPORT

BLDG NO.	BLDG NAME	ANNUAL ELEC HEATING (MMBTU)	ANNUAL REFRIG COOLING (MMBTU)	ANNUAL EVAP COOLING (MMBTU)	ANNUAL LIGHTING (MMBTU)	ANNUAL EQUIP (MMBTU)	ANNUAL ELEC DHW (MMBTU)	TOTAL ELEC ENERGY (MMBTU)	ANNUAL FUEL HEAT (MMBTU)	ANNUAL FUEL DHW (MMBTU)	TOTAL ENERGY (MMBTU)
2	H.Q.	0.0	1137.8	0.0	710.6	10.7	0.00	1859	158.4	0.00	2017
3	S.S. SUPPLY	0.0	87.7	76.4	77.7	2.1	0.00	243	232.2	0.00	475
4	SERVICE STATION	62.3	0.0	51.0	29.2	6.2	0.00	148	0.0	0.00	148
5	SIGNAL	0.0	870.6	0.0	444.2	2984.1	0.00	4298	130.3	0.00	4428
6	SUPPLY WHSE	116.4	37.1	0.0	4.1	1.7	0.00	159	0.0	0.00	159
101	CLO/LIQUOR STORE	240.6	146.2	0.0	46.5	7.6	0.00	440	0.0	0.00	440
102	COMMISSARY WHSE.	0.0	0.0	24.1	34.8	0.0	0.00	58	0.0	0.00	58
103	COMMISSARY WHSE.	0.0	0.0	68.0	34.8	0.0	0.00	102	0.0	0.00	102
104	COMMISSARY WHSE.	0.0	0.0	85.0	36.9	8.0	0.00	129	0.0	0.00	129
105	COMMISSARY SALES	128.6	1091.8	17.0	147.7	2371.6	4.06	3760	465.3	6.97	4232
106	COMM. FREEZER	0.0	648.7	0.0	1.9	0.0	0.00	650	0.0	0.00	650
106	VETS OFFICE	0.0	32.5	0.0	3.0	2.2	0.29	37	0.0	0.00	37
110	HEALTH CL SUPPLY	0.0	0.0	51.0	9.2	7.6	0.00	67	0.0	0.00	67
120	BOWLING ALLEY	162.2	1136.7	0.0	250.0	465.8	0.00	2014	159.8	24.96	2198
124	WHSE,COMM COMPUT	27.7	42.7	68.0	18.0	1.6	0.00	158	0.0	0.00	158
204	AUTO GARAGE	0.0	356.9	12.2	136.4	46.9	0.00	552	110.7	0.00	662
205	DIV OFF & CNTRL	0.0	239.0	0.0	158.1	63.6	0.00	460	55.0	0.00	515
206	TIRE SHOP	0.0	83.6	34.0	14.1	4.3	8.91	144	91.6	0.00	235
215	DISPATCH FACILTY	41.5	146.3	0.0	125.5	6.5	3.86	323	0.0	0.00	323
226	VET CLINIC	37.8	102.0	0.0	66.3	88.5	2.67	297	0.0	0.00	297
232	MILITARY POLICE	0.0	268.4	0.0	106.7	11.7	0.86	387	47.0	0.00	434
300	OFF UNOCC	0.0	359.0	0.0	69.7	0.0	0.00	428	107.4	0.00	535
301	POST OFFICE	0.0	206.1	0.0	63.8	22.8	0.00	292	57.0	0.00	349
302	SECURITY	0.0	445.2	0.0	86.8	68.2	0.00	600	119.5	2.07	721
303	OFFICE	0.0	377.7	0.0	123.3	0.0	0.00	501	108.0	0.83	609
304	SECURITY	0.0	385.0	0.0	122.5	59.0	0.00	566	108.6	1.93	676
305	CORPS OF ENG	0.0	384.5	0.0	65.6	8.0	0.00	458	125.5	0.27	583
306	OFF UNOCC	0.0	410.4	0.0	136.7	0.0	0.00	547	137.9	0.69	685
307	PARA CLUB	0.0	451.6	0.0	63.6	6.5	0.00	521	138.1	0.27	659
308	BOY SCOUTS	0.0	403.9	0.0	28.0	0.4	0.00	432	138.3	0.13	570
309	STORAGE	0.0	408.3	0.0	22.9	0.0	0.00	431	142.5	0.82	574
400	ENG PLANS & SERV	0.0	138.0	0.0	150.1	23.4	0.00	311	42.0	1.65	354
402	FACILITIES ENG	0.0	244.8	0.0	158.1	17.3	5.93	426	54.7	0.00	480
403	SUPPLY WAREHSE	0.0	55.7	20.8	17.5	41.6	0.00	135	0.0	0.00	135
404	A/C & REFRIG SHP	0.0	111.5	51.0	31.2	0.0	0.59	194	39.2	0.00	233
408	WOOD SHOP OFF	0.0	111.5	30.5	13.6	161.4	0.00	317	0.0	0.00	317
409	PAINT SHOP	166.5	146.2	0.0	31.8	0.0	0.00	344	0.0	0.00	344
451	NCO CLUB	0.0	591.1	0.0	331.7	120.7	0.00	1043	128.1	5.69	1176
452	JUDGE ADVOCATE	28.0	114.9	0.0	112.5	12.0	0.89	268	0.0	0.00	268
500	EDUC CNTR	0.0	314.8	0.0	126.2	4.3	0.00	445	127.0	0.82	572
501	EM BARRACKS	0.0	446.4	0.0	135.5	3.4	0.00	585	137.3	134.64	856
503	EM BARRACKS	0.0	460.5	0.0	102.3	2.9	0.00	565	142.7	134.64	842
504	PX/RECREATION	0.0	978.4	0.0	595.0	97.8	17.82	1689	346.4	0.00	2035
505	CRAFTS	171.9	333.6	0.0	86.4	97.9	1.18	690	0.0	0.00	690
506	E.M.B. OLD WING	0.0	2281.7	0.0	1748.4	494.0	0.00	4524	1359.0	808.99	6691
506	E.M.B. NEW WING	0.0	1656.9	0.0	1435.3	426.9	0.00	3519	905.8	999.35	5424
506	E.M.B. MESS HALL	0.0	551.0	0.0	374.7	91.2	0.00	1016	359.1	41.71	1416

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Exhibit 8 . (cont'd)

Y.P.G. BUILDING ENERGY USE REPORT

BLDG NO.	BLDG NAME	ANNUAL ELEC HEATING (MMBTU)	ANNUAL REFRIG COOLING (MMBTU)	ANNUAL EVAP COOLING (MMBTU)	ANNUAL LIGHTING (MMBTU)	ANNUAL EQUIP (MMBTU)	ANNUAL ELEC DHW (MMBTU)	TOTAL ELEC ENERGY (MMBTU)	ANNUAL FUEL HEAT (MMBTU)	ANNUAL FUEL DHW (MMBTU)	TOTAL ENERGY (MMBTU)
515	THEATER	0.0	658.2	0.0	33.7	4.7	0.00	696	108.7	0.00	804
518	GYM AND OFFICE	38.0	210.7	102.0	84.2	0.0	0.00	434	357.4	3.18	794
520	REC OFF & BATH	33.2	113.3	13.5	30.3	0.0	0.89	191	0.0	0.00	191
530	E.M.SERVICE CLUB	0.0	534.5	0.0	157.8	48.4	5.93	746	308.3	0.00	1054
611	PRE-SCHOOL	261.5	344.3	0.0	32.1	2.2	13.36	653	0.0	0.00	653
701	PESONNEL	0.0	126.7	0.0	37.7	5.3	2.37	172	21.7	0.00	193
702	CIV PERSONNEL	0.0	341.0	0.0	144.8	23.4	0.00	509	62.6	0.00	571
712	COMPUTER CENTER	0.0	482.3	0.0	518.8	601.2	0.00	1602	41.5	1.93	1645
714	FINANCE OFFICE	0.0	478.8	0.0	300.2	32.7	8.02	819	69.0	0.00	888
990	HEALTH CLINIC	0.0	408.1	0.0	475.4	26.4	0.00	909	333.4	250.15	1492
1000	CHILD CARE CNTR	0.0	784.8	0.0	32.3	11.0	17.64	845	307.5	0.00	1152
1001	OFCR'S OPEN MESS	0.0	534.9	17.0	241.3	1444.9	7.12	2245	114.2	11.63	2370
1003	GUEST HOUSE	0.0	646.3	0.0	210.9	248.7	0.00	1105	115.6	113.60	1334
1004	B.O.Q.	0.0	2168.3	0.0	1032.3	824.3	0.00	4024	361.9	151.47	4537
1100	CHAPEL & ED. BLD	0.0	987.3	0.0	44.6	51.5	8.61	1092	198.5	0.00	1290
1220	DENTAL CLINIC	66.0	146.7	0.0	99.1	154.1	5.34	471	0.0	0.00	471
2000	PRINTING PLANT	0.0	173.3	0.0	150.1	77.0	2.37	402	58.5	0.00	460
2060	PETRO LAB	0.0	420.6	0.0	34.8	0.0	44.55	499	148.9	0.00	647
2065	DISPATCH	0.0	166.9	17.0	42.3	18.5	0.00	244	44.4	0.00	288
2067	ENG EQMT	0.0	56.0	17.0	10.7	1.3	0.00	85	60.2	5.53	150
2075	METAL SHOP	0.0	658.9	40.7	289.1	548.4	0.00	1537	0.0	0.00	1537
2090	AIRBORNE TEST FC	0.0	335.4	12.0	183.4	83.7	2.97	617	154.2	0.00	771
2091	TANK AUTOMATD CM	61.3	152.0	0.0	91.1	2.1	0.00	306	0.0	0.00	306
2096	MOBILITY INSTRMT	0.0	181.5	0.0	81.1	32.1	1.78	296	469.7	0.00	765
2100	ADMIN	0.0	770.3	0.0	294.8	32.8	11.88	1109	321.4	0.00	1430
2102	PHOTO	0.0	260.8	0.0	58.6	83.7	0.00	403	104.9	13.83	521
2104	CALIBRATION	0.0	624.2	0.0	112.6	1099.0	5.20	1841	68.2	0.00	1909
2105	RANGE OPERATIONS	0.0	4013.2	0.0	6248.7	21280.5	0.00	31542	1172.0	28.60	32742
2210	MOB OPER BRANCH	0.0	124.2	68.0	146.6	48.8	1.18	388	44.1	0.00	432
2212	MTD CONTROL	0.0	129.1	0.0	13.4	5.5	2.08	150	0.0	0.00	150
2220	ELEC MAINTENANCE	83.4	131.1	34.0	66.0	6.0	4.45	324	0.0	0.00	324
2500	SOILS LAB	0.0	143.6	0.0	60.5	4.9	0.00	209	39.7	0.00	248
2650	OFF/STOR	43.7	75.5	0.0	8.5	0.6	0.00	128	0.0	0.00	128
2660	SUPPLY WHSE OFF	0.0	111.5	34.0	109.1	9.3	0.00	263	204.2	0.00	467
2700	ATMOS SCIENCES	0.0	227.2	0.0	69.5	8.7	0.00	305	66.9	0.00	371
2710	TERMINAL OFF	0.0	115.6	12.0	42.0	0.0	0.00	169	149.5	0.00	318
3005	PARACHUTE BLDG	0.0	107.1	68.0	66.2	4.3	2.67	248	0.0	0.00	248
3007	INSTRUMENT SHOP	49.9	112.0	0.0	28.4	3.8	0.00	194	0.0	0.00	194
3008	HANGAR	47.5	105.0	159.3	20.5	0.6	0.00	332	0.0	0.00	332
3009	AVIONICS REPAIR	0.0	55.7	0.0	18.4	0.0	0.00	74	0.0	0.00	74
3010	COPTER WHSE	0.0	220.0	0.0	35.9	1.3	0.00	257	0.0	0.00	257
3011	AIR DISPATCH	0.0	144.8	0.0	73.1	16.2	0.00	234	0.0	0.00	234
3012	CONTROL TOWER	65.7	313.9	0.0	0.3	61.0	0.00	440	0.0	0.00	440
3013	FIRE AND RESCUE	0.0	646.9	17.0	232.3	361.6	26.45	1284	193.4	0.00	1477
3014	CONTROL BLDG	20.7	49.4	0.0	0.0	182.9	0.00	253	0.0	0.00	253
3015	COPTER HANGAR	124.3	287.4	34.0	525.0	32.1	5.93	1008	0.0	0.00	1008
3017	ORG MAINT OFF	100.5	298.1	99.8	503.5	41.4	3.56	1046	0.0	0.00	1046

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Exhibit 8. (cont'd)

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Y.P.G. BUILDING ENERGY USE REPORT

BLDG NO.	BLDG NAME	ANNUAL ELEC HEATING (MMBTU)	ANNUAL REFRIG COOLING (MMBTU)	ANNUAL EVAP COOLING (MMBTU)	ANNUAL LIGHTING (MMBTU)	ANNUAL EQUIP (MMBTU)	ANNUAL ELEC DHW (MMBTU)	TOTAL ELEC ENERGY (MMBTU)	ANNUAL FUEL HEAT (MMBTU)	ANNUAL FUEL DHW (MMBTU)	TOTAL ENERGY (MMBTU)
3021	AIR ADMIN	0.0	457.5	0.0	161.8	6.7	0.00	626	66.6	0.00	692
3022	PARACHUTE MAINT	0.0	425.6	0.0	192.9	30.1	2.37	650	177.2	0.00	827
3120	MASTER CONTROL	0.0	79.1	0.0	4.1	0.0	0.00	83	0.0	0.00	83
3125	TEST PREP FACIL	154.3	575.7	0.0	198.3	887.6	4.45	1820	0.0	0.00	1820
3482	TEST PREP FAC	384.1	1114.6	0.0	991.8	275.8	4.45	2770	0.0	0.00	2770
3483	LOCKER & LUNCH	72.8	228.0	0.0	8.3	12.5	8.91	330	0.0	0.00	330
3490	N. WEAPONS REP.	0.0	979.3	0.0	513.5	179.8	0.00	1672	856.9	0.00	2528
3490	S. & OFFICE	0.0	351.5	170.0	3511.1	197.1	0.00	4229	104.7	22.13	4355
3493	X-RAY	119.7	637.8	0.0	93.8	1287.9	4.15	2143	0.0	0.00	2143
3495	CONTROL ROOM	0.0	37.1	0.0	2.2	3.7	0.00	43	0.0	0.00	43
3496	CONTROL ROOM	0.0	111.5	0.0	1.6	2.2	0.00	115	0.0	0.00	115
3509	DISASSEMBLY BLDG	0.0	64.0	0.0	0.5	4.5	0.00	69	0.0	0.00	69
3510	STORAGE BAYS	0.0	675.8	0.0	3.6	0.0	0.00	679	0.0	0.00	679
3511	LOCKER ROOM	0.0	124.0	0.0	0.9	1.3	2.37	128	25.7	0.00	153
3512	DISASSEMBLY PLNT	0.0	625.0	0.0	67.8	0.0	0.00	692	105.0	1.38	798
3518	DATA MAINT CONTR	0.0	261.0	17.0	25.1	0.0	0.89	303	0.0	0.00	303
3519	ELEC MAINT	0.0	435.7	0.0	235.8	18.7	5.93	696	167.5	0.00	863
3520	PHYS TEST	0.0	419.4	0.0	173.2	133.7	0.00	726	115.8	0.41	842
3521	SUPPORT SERVICES	0.0	337.6	0.0	80.4	0.0	1.48	419	113.4	0.00	532
3522	WPN & ARMS MAINT	184.3	167.3	24.9	96.5	27.3	1.78	502	47.9	0.00	549
3523	REALTIME MISSION	0.0	484.8	0.0	215.0	497.5	4.15	1201	84.8	0.00	1285
3524	EXCHANGE BRANCH	49.9	127.2	0.0	4.6	41.8	3.56	227	0.0	0.00	227
3528	DISPATCH OFF	22.0	55.1	0.0	10.7	1.0	0.00	88	0.0	0.00	88
3537	SECURITY	70.8	94.7	0.0	9.3	3.3	0.59	178	0.0	0.00	178
3555	MET TEAM	0.0	167.3	17.0	34.6	6.7	0.00	225	0.0	0.00	225
3556	BELL TECH CONTR	0.0	55.7	0.0	2.3	5.5	0.00	63	0.0	0.00	63
3557	SECURITY BLDG	0.0	202.0	0.0	1.6	0.0	0.00	203	0.0	0.00	203
3566	INERT LOADING	0.0	170.6	51.0	131.4	48.6	0.00	401	492.4	0.82	894
3586	WEAPONS STORAGE	0.0	49.4	0.0	9.3	0.0	0.00	58	0.0	0.00	58
3598	LAVATORY	0.0	109.3	0.0	13.9	0.0	0.00	123	21.0	0.00	144
3599	BELL TECH RADAR	0.0	40.3	27.1	23.2	0.0	0.00	90	83.5	0.00	173
3632	VELOCITY FACILTY	48.3	99.7	0.0	3.3	20.0	0.00	171	0.0	0.00	171
3659	COMMUNICATION BL	44.3	141.2	0.0	55.2	67.0	0.00	307	0.0	0.00	307
3699	COMM BLDG	0.0	156.3	0.0	0.0	10.1	0.00	166	0.0	0.00	166
3743	AMMO OFF	56.9	156.7	0.0	13.0	6.7	1.78	235	0.0	0.00	235
5100	MAINTENANCE SHOP	0.0	103.7	102.0	3.3	0.0	0.00	209	92.2	0.00	301
6000	TELEPHONE EXCHNG	0.0	294.3	0.0	102.2	79.5	0.00	476	80.2	0.13	556
6003	DRONE TESTING	0.0	348.2	0.0	222.4	0.0	5.93	576	97.2	0.00	673
6004	PHOTO INSTR DRO	0.0	200.2	0.0	34.7	13.3	0.00	248	64.6	0.54	313
6006	DRON TESTING FAC	0.0	190.9	0.0	3.3	0.0	0.00	194	57.0	0.00	251
6071	HANGAR & DRONE	0.0	853.1	0.0	1340.5	401.7	0.00	2595	692.1	0.00	3287
7001	OBSERVATION	47.8	94.9	0.0	24.9	0.0	0.00	167	0.0	0.00	167
** TOTAL **		3434.4	51277.2	1743.3	30402.8	39648.9	284.20	126728	15520.6	2771.76	144983

Exhibit 9. 10 HIGHEST ENERGY CONSUMING BUILDINGS AT YPG

PAGE NO. 00001

Y.P.G. BUILDING ENERGY USE REPORT

BLDG NO.	BLDG NAME	ANNUAL ELEC HEATING (MMBTU)	ANNUAL REFRIG COOLING (MMBTU)	ANNUAL EVAP COOLING (MMBTU)	ANNUAL LIGHTING (MMBTU)	ANNUAL EQUIP (MMBTU)	ANNUAL ELEC DHW (MMBTU)	TOTAL ELEC ENERGY (MMBTU)	ANNUAL FUEL HEAT (MMBTU)	ANNUAL FUEL DHW (MMBTU)	TOTAL ENERGY (MMBTU)
2105	RANGE OPERATIONS	0.0	4013.2	0.0	6248.7	21280.5	0.00	31542	1172.0	28.60	32742
506	E.M.B. OLD WING	0.0	2281.7	0.0	1748.4	494.0	0.00	4524	1359.0	808.99	6691
506	E.M.B. NEW WING	0.0	1656.9	0.0	1435.3	426.9	0.00	3519	905.8	999.35	5424
3490	N. WEAPONS REP.	0.0	979.3	0.0	513.5	179.8	0.00	1672	856.9	0.00	2528
3490	S. & OFFICE	0.0	351.5	170.0	3511.1	197.1	0.00	4229	104.7	22.13	4355
1004	B.O.Q.	0.0	2168.3	0.0	1032.3	824.3	0.00	4024	361.9	151.47	4537
5	SIGNAL	0.0	870.6	0.0	444.2	2984.1	0.00	4298	130.3	0.00	4428
105	COMMISSARY SALES	128.6	1091.8	17.0	147.7	2371.6	4.06	3760	465.3	6.97	4232
6071	HANGAR & DRONE	0.0	853.1	0.0	1340.5	401.7	0.00	2595	692.1	0.00	3287
3482	TEST PREP FAC	384.1	1114.6	0.0	991.8	275.8	4.45	2770	0.0	0.00	2770
1001	OFCR'S OPEN MESS	0.0	534.9	17.0	241.3	1444.9	7.12	2245	114.2	11.63	2370
120	BOWLING ALLEY	162.2	1136.7	0.0	250.0	465.8	0.00	2014	159.8	24.96	2198
** TOTAL **		674.9	17052.6	204.0	17904.8	31346.5	15.63	67192	6322.0	2054.10	75562

Exhibit 10. FAMILY HOUSING ENERGY USE REPORT

PAGE NO. 00001
04/19/82

Y.P.G. FAMILY HOUSING DATA BASE

CONST TYPE	SIMILAR CONST TYPES	TOTAL NUMBER OF UNITS	TOTAL FLOOR AREA(SF)	PEAK HEATING LOAD (KBTUH)	PEAK COOLING LOAD (KBTUH)	ANNUAL HEATING LOAD (MMBTU)	ANNUAL COOLING LOAD (MMBTU)	ANNUAL LIGHTING (MMBTU)	ANNUAL EQUIPMENT AND APPL (MMBTU)	ANNUAL DHW (MMBTU)	ANNUAL TOTAL (MMBTU)
H	3,C,A	13	19402	280.8	716.4	583.4	880.7	598.4	1704.0	552.5	4319.0
E	D,F,G	38	57322	866.4	2131.8	1345.7	2849.8	2049.1	5832.0	1615.0	13691.6
K	6,J,M	66	66738	1036.2	2673.0	2154.2	3066.2	2815.2	8013.8	1862.5	17911.9
7	I	104	116934	1669.2	4378.4	3518.3	5008.8	4437.0	12624.2	4420.0	30008.3
5	1,2,4	68	75726	1149.2	3080.4	2090.3	3626.7	2903.6	8262.0	2890.0	19772.6
** TOTAL **		289	336122	5001.8	12980.0	9691.9	15432.2	12803.3	36436.0	11340.0	85703.4

3.0. ENERGY CONSERVATION MEASURES DEVELOPED

3.1. GENERAL DISCUSSION

Results of the EEAP analysis for Increments A, B, G, and F include the development and documentation of 6 Increment A and B (ECIP projects), 13 Increment G projects, and 134 Increment F projects. Exhibit 2 summarizes and prioritizes the results of all 19 ECIP and Increment G projects. Exhibit 3 summarizes and prioritizes the results for all 134 Increment F projects. Section 3.2 includes the descriptions of all ECIP projects, Section 3.3 includes the descriptions of all Increment G projects, and Section 3.4 includes the descriptions of all Increment F projects. In addition, the analysis of two alternative EMCS's are discussed in Section 3.5. Complete DD 1391'S and PDB's are provided for the 10 selected ECIP and Increment G projects in Volume III. DD 1391 cover sheets are provided for the remaining ECIP and Increment G projects in Volume IV.

3.2. INCREMENT A & B ECIP PROJECTS

Included in this section are detailed descriptions of all Increment A and B projects that meet ECIP criteria as outlined in the ECIP guidance dated 29 January 1980.

ECIP Project to Install New Lighting Systems

A. Project Summary and Description

There are several buildings at YPG where lighting systems and fixtures are of outdated design or simply worn out. Replacement of these fixtures with more efficient fluorescent and high pressure sodium lamps would reduce lighting energy consumption and space cooling loads that result from the internal heat they generate. Implementation of this project includes three types of replacements:

1. Upgrade incandescent and 4-lamp fluorescent fixtures and old, yellowed lenses with higher efficiency fluorescent fixtures.

2. Retrofit existing incandescent standard base socket with "circular" fluorescent fixtures.

3. Replace high-wattage inefficient mercury vapor lamps with more efficient high-pressure sodium lamps.

Installation of these items will cause minimal inconvenience to building occupants.

B. ECIP Savings:

1. Estimated Annual Dollar Savings: $30,858
2. Annual MMBTU Savings: 2560
3. Simple Amortization Period (SAP): 4.8 years
4. B/C Ratio: 1.98
5. E/C Ratio: 17.8

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
2	14,000	S	Office
520	1,400	P	Institutional
990	10,200	S	Hospital
1000	8,000	S	School
1003	6,490	S	Housing
1004	21,600	P	Housing
3015	13,200	P	R & D
3017	12,000	P	R & D
3482	14,219	P	R & D

*S=Semi-permanent, P=Permanent

ECIP Project to Improve Thermal Performance of Roofs

A. Project Summary and Description

Many buildings at YPG have poorly insulated roofs. Roof surfaces are also highly absorptive of solar radiation. Various energy conservation measures can be implemented to overcome these problems, including the installation of insulated dropped ceilings, application of highly reflective roof coatings and the addition of exterior rigid foam insulation. These measures can greatly reduce heating and cooling loads by increasing the thermal resistance and lowering the absorptivity of the roof surface. Implementation of this project would require different procedures for each building type and usage. Some examples are listed below:

1. Buildings with accessible attics generally need several inches of "blown-in" fiberglass insulation, resulting in increased thermal resistance of R = 3.1 per inch.

2. Frame structures without attics require the installation of suspended ceilings (if interior height permits) which may then be insulated with fiberglass batt insulation.

3. Most metal buildings are best upgraded with sprayed-on exterior foam insulation covered with a highly reflective and durable final coating.

All of these methods involve standard construction techniques. Interruption of normal businees routines would occur only in buildings requiring installation of suspended ceilings. Even in these cases the disruption would be minimal.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $23,579
2. Annual MMBTU Savings: 2656
3. Simple Amortization Period (SAP): 6.4 years
4. B/C Ratio: 2.2
5. E/C Ratio: 17.7

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
Ceiling Insulation			
2	14,000	S	Office
101	4,314	S	Service
2060	4,000	S	Other
2067	4,000	S	Storage
2210	7,200	S	R & D
2500	1,680	S	R & D
3537	936	P	Office
Roof Insulation			
5	6,230	P	Computer
105	10,156	S	Service
205	3,265	S	Office
232	1,960	S	Service
2091	1,200	S	R & D
3022	6,120	P	Service
3483	1,408	P	Service
3511	1,092	P	Service
3659	1,000	P	Service
6000	3,362	P	Service
6004	2,160	P	R & D
6006	4,116	S	R & D
Reflective Roof Coating			
215	1,820	P	Office
400	3,222	S	Office
403	1,280	S	Storage
408	4,800	S	Service
409	800	S	Service
452	1,575	S	Office
505	5,760	S	Institutional

(cont'd on following page)

Bldg No.	SF Area	S or P*	Use
714	4,852	S	Office
1001	7,415	S	Institutional
2000	4,240	S	Office
2065	4,000	S	Office
2220	4,000	S	Office
2700	4,000	S	R & D
3007	1,200	S	R & D
3008	8,000	S	R & D
3010	6,000	S	R & D
3490 S.	59,400	P	R & D
3518	4,000	S	R & D
3524	800	S	Service
3557	4,000	S	Office

*S=Semi-permanent, P=Permanent

ECIP Project to Install Night Setback Thermostats for Family Housing

A. Project Description

A large amount of energy can be saved in family housing by lowering thermostat settings a few degrees at night during the heating season. Providing new thermostats with automatic setback capability would facilitate this type of energy conservation while maintaining a reasonable level of comfort.

Implementation of this project would require the installation of a new, wall-mounted thermostat in each single family residence. A single visit by an electrician is the only inconvenience occupants should experience.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $11,445
2. Annual MMBTU Savings: 1930
3. Simple Amortization Period (SAP): 10.6
4. B/C Ratio: 1.1
5. E/C Ratio: 16.0

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Family Hsg. Unit Types	SF Area	S or P*	Use
3,A,C,H	19,402	P	Housing
E,D,F,G	57,322	P	Housing
6,J,K,M	66,738	P	Housing
7,I	116,934	P	Housing
1,2,4,5	75,726	P	Housing

*S=Semi-permanent, P=Permanent

ECIP Project to Install Solar DHW Systems & Conserve Water

A. Project Description

This project is a combination of strategies designed to reduce energy consumed for domestic hot water heating. The project involves installing solar domestic hot water systems and water flow restrictors for showers in buildings with large hot water use.

Solar DHW

Each of the seven buildings involved will be provided with solar collectors, control systems, pumps, insulated storage tanks, and associated plumbing and valves. In certain applications the proposed solar energy systems will be interconnected with the existing domestic hot water system. For other applications the existing systems are inefficient and new water heaters, heat exchangers and circulation pumps will be required. Over the entire year, it has been estimated that 80 to 90% of the DHW load can be supplied by the solar energy system, either in the form of make-up water preheat or direct water heating, thus minimizing fuel consumption.

Flow Restrictors for Showers

Each of the six buildings included are either barracks or other housing quarters. By installing a shower head which restricts the flow rate of water to 1.8 gallons per minute it is estimated that hot water consumption for showers can be reduced by as much as 20 to 30%.

Additional energy savings achieved by less power consumed at pumping stations has been accounted for in this project.

B. ECIP Savings

1. Estimated Annual Dollars Savings: $38,355
2. Annual MMBTU Savings: 2,464
3. Simple Amortization Period (SAP): 4.3
4. B/C Ratio: 4.5
5. E/C Ratio: 15.0

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted improvement:

Bldg No.	SF Area	S or P*	Use
Solar Domestic Hot Water			
501	6,135	S	Housing
503	6,135	S	Housing
506	70,300	P	Housing
1003	6,490	S	Housing
1004	21,600	P	Housing
2060	4,000	S	Other
3013	6,734	P	Service
Flow Restrictors (Showers)			
501	6,135	S	Housing
503	6,135	S	Housing
506 O.W.	33,300	P	Housing
506 N.W.	30,200	P	Housing
1003	6,490	S	Housing
1004	21,600	P	Housing

*S=Semi-permanent, P=Permanent

ECIP Project to Install Blown-In Insulation on Exterior Walls

A. Project Summary and Description

There are many frame construction buildings at YPG whose walls have poor insulating characteristics. Providing blown-in fiberglass or mineral wool insulation inside these walls would greatly reduce heating and cooling loads by increasing thermal resistance.

Implementation of this project requires one of two basic procedures, depending on the construction of the particular building:

1. Wood frame buildings would have holes drilled in the stucco outer layer through which insulation would be blown into the wall cavity. The stucco would then have to be patched and much of the building exterior repainted.

2. Metal buildings with metal stud exterior wall framing would generally require partial removal and replacement of exterior metal sheathing to allow insulation to be blown in.

Both of these methods utilize standard practices which may be implemented by local contractors. Since only exterior construction is involved, no disruption of normal occupant routines is anticipated.

B. ECIP Savings

1. Estimated annual dollar savings: $40,405
2. Annual MMBTU savings: 3226
3. Simple Amortization Period (SAP): 5.8 years
4. B/C Ratio: 2.6
5. E/C Ratio: 13.7

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected to be included in the above-noted project:

Bldg No.	SF Area	S or P*	Use
101	4,314	S	Service
105	10,156	S	Service
300	5,452	S	Housing
301	1,764	S	Service
302	5,457	S	Office
303	5,452	S	Unoccupied
304	5,452	S	Office
305	5,452	S	Office
306	5,996	S	Unoccupied
308	5,996	S	Institutional
309	5,996	S	Unoccupied
402	3,640	S	Office
500	6,135	S	School
501	6,135	S	Housing
503	6,135	S	Service
505	5,760	S	Institutional
701	1,750	S	Office
702	5,382	S	Office

(cont'd on following page)

Bldg No.	SF Area	S or P*	Use
714	4,852	S	Office
2060	4,000	S	Other
3011	1,280	S	Office
3519	6,000	S	R & D
3520	4,000	S	R & D

*S=Semi-permanent, P=Permanent

3.3. INCREMENT G PROJECTS

Included in this section are detailed descriptions of all Increment G projects that do not meet ECIP criteria as outlined in the ECIP guidance dated 29 January 1980.

Project to Install Movable Insulation for Windows

A. Project Description

The purpose of this project is to control solar heat gain and reduce heat loss from windows in Buildings 506 and 1004. These living quarters have large window areas through which solar heat gain can be beneficial if controlled for optimal winter use. In a hot arid climate such as YPG, solar heat gain through windows accounts for a very significant portion of the space cooling load.

If properly controlled, movable insulation can be very beneficial. By closing insulation over the windows on cold winter nights and sunny summer afternoons and by opening insulation on cool summer nights and sunny winter days, the additional thermal resistance provided by movable insulation can be beneficial for both space heating and cooling.

There are many different types of movable insulation. The most appropriate for YPG's climate is an insulating window drape system with a reflective fabric liner. Thermal resistance of drapes is not effective unless the perimeter (top,sides and bottom) can be secured to prevent air from flowing behind the drapes. One typical design is to incorporate tracks along the top and bottom in which the drapes slide while being opened or closed. The proposed system must be manually operated by the occupants or maid service.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $19,523
2. Annual MMBTU Savings: 1498
3. Simple Amortization Period (SAP): 6.2
4. B/C Ratio: 1.8
5. E/C Ratio: 12.5

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted improvement:

Bldg No.	SF Area	S or P*	Use
5Ø6 O.W.	333ØØ	P	Housing
5Ø6 N.W.	3Ø2ØØ	P	Housing
1ØØ4	216ØØ	P	Housing

*S=Semi-permanent, P=Permanent

Project to Install Weatherstripping

A. Project Description

This project will reduce infiltration/exfiltration through doors. Weatherstripping jambs, heads and thresholds is proposed. For the buildings scheduled for this project, weatherstripping is nonexistent. Large gaps exist at the bottoms of exterior doors.

B. Project Savings

1. Estimated Annual Dollar Savings: $67Ø
2. Annual MMBTU Savings: 5Ø.4
3. Simple Amortization Period (SAP): 3.4
4. B/C Ratio: 4.5
5. E/C Ratio: 22.Ø

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
3ØØ	5,452	S	Housing
3Ø2	5,452	S	Office
3Ø3	5,452	S	Unoccupied
3Ø4	5,452	S	Office
3Ø5	5,452	S	Office
3Ø6	5,996	S	Unoccupied
3Ø8	5,996	S	Institutional
3Ø9	5,996	S	Unoccupied
5ØØ	6,135	S	School

*S=Semi-permanent, P=Permanent

Project to Install Solar Energy DHW Systems and Conserve Water in Family Housing

A. Project Description

This project is a combination of strategies designed to reduce energy consumed for domestic hot water use in family housing at YPG. The project includes the installation of passive solar "bread box" water heating systems and water flow restrictors for showers.

Passive Solar DHW

Each single family housing unit should be provided with two 30 gallon "bread box" type solar energy collectors, associated hardware, piping and valves. The existing electric hot water heaters will be used as backup heaters connected in series with the passive solar system. Over the entire year it is estimated that 80 to 85% of the DHW load can be supplied by the solar energy system in the form of make-up water preheat or direct water heating. This system requires the least annual maintenance of any system considered.

Flow Restrictors For Showers

Each family housing living unit will be retrofitted with a new shower head which restricts the flow rate of water to 1.8 gallons per minute. It is estimated that hot water consumption for showers can be reduced by as much as 20 to 30%.

The additional energy savings that will result from reduction of electrical power consumed at pumping stations has also been accounted for.

B. Savings

1. Estimated Annual Dollar Savings: $44,946
2. Annual MMBTU Savings: 10,089
3. Simple Amortization Period (SAP): 19.8
4. B/C Ratio: 0.86
5. E/C Ratio: 11.3

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Family Hsg. Unit Type	SF Area	S or P*	Use
Bread-Box Solar Energy Collectors			
3,A,B,C,H	19,402	P	Housing
E,D,F,G	57,322	P	Housing
6,J,K,M	66,738	P	Housing
7,I	11,934	P	Housing
1,2,4,5	75,726	P	Housing
Flow Restrictors			
3,A,C,H	19,402	P	Housing
E,D,F,G	57,322	P	Housing
6,J,K,M	66,738	P	Housing
7,I	11,934	P	Housing
1,2,4,5	75,726	P	Housing

*S=Semi-permanent, P=Permanent

Project to Install Exterior Roof Insulation in Family Housing

A. Project Description

Many family housing units at YPG have roof structures which are poorly insulated. Roof surfaces are also highly absorptive of solar radiation. Installation of a sprayed-on layer of urethane foam finished with a highly reflective coating could greatly reduce conductive heat loss/gain and radiative heat gain.

Implementation of this project requires the application of one inch of sprayed-on urethane foam insulation with a special reflective finish. For existing tar and gravel roofs, gravel must be removed and the surface prepared to receive the foam urethane. Since only exterior construction is involved, no disruption of normal occupant routines is anticipated.

B. Project Savings

1. Estimated Annual Dollar Savings: $39,784
2. Annual MMBTU Savings: 5,519
3. Simple Amortization Period (SAP): 20.1
4. B/C Ratio: 0.77
5. E/C Ratio: 6.9

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg Type	SF Area	S or P*	Use
3,A,B,C,H	19,402	P	Housing
E,D,F,G	57,322	P	Housing
6,J,K,M	66,738	P	Housing
7,I	116,934	P	Housing
1,2,4,5	75,726	P	Housing

*S=Semi-permanent, P=Permanent

Project to Install Surface-Applied Insulation to Exterior Walls

A. Project Summary and Description

There are many buildings at YPG with concrete masonry unit construction that are uninsulated. Placing insulating foam on the exterior of these buildings would not only improve the thermal resistance of their walls but also allow the structure of the buildings to perform as a thermal storage mass. This would lower heating and cooling loads. Peak loads can also be reduced since the effects of mid-afternoon heat gain will be delayed until early evening when base wide electrical consumption is much less.

This project will involve sandblasting of cinder block walls, applying rigid foam insulation, laying up fiberglass reinforcing mesh, applying acrylic plaster, and finishing around doors and windows.

The tough, stucco-like finish provided by acrylic plaster would reduce exterior maintenance and blend in well with the appearance of other structures at YPG. Since application of this insulation system involves only exterior construction, activities inside the building would be virtually unaffected.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $72,284
2. Annual MMBTU Savings: 3,723
3. Simple Amortization Period (SAP): 7.5 years
4. B/C Ratio: 2.4
5. E/C Ratio: 7.5

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
5	6,230	P	Computer
226	1,144	P	Hospital
232	1,960	S	Service
506 O.W.	33,300	P	Housing
506 N.W.	30,200	P	Housing
1004	21,600	P	Housing
2104	4,740	P	R & D
3021	6,733	P	Office
3483	1,408	P	Service
3490 S	59,400	P	R & D
3511	1,092	P	Service
3537	936	P	Office
3632	852	P	R & D
3659	1,000	P	Service
3743	1,600	P	Office
6000	3,362	P	Service
6003	4,400	P	R & D
6004	2,160	P	R & D

*S=Semi-permanent, P=Permanent

Project to Install Sunscreens for Windows

A. Project Description

This project is designed to reduce unwanted solar heat gain through windows before it enters the building. In a hot arid climate such as at YPG, unshaded windows or windows with only interior shading devices enhance conduction and radiation of outside heat to the conditioned space within at a faster rate than it can be removed by mechanical refrigeration. Windows on east- and west-facing walls generally create the worst problems and have been given special attention in this analysis. We propose that louvered sunscreens be installed on the outside of windows. These will provide a shading coefficient of 0.3, glare-free daylighting, and good outward visibility. Actual energy reductions of the cooling load will vary depending on the orientation and glazing area of each building.

B. Project Savings

1. Estimated Annual Dollar Savings: $5,147
2. Annual MMBTU Savings: 497
3. Simple Amortization Period (SAP): 15.3

4. B/C Ratio: 0.66
5. E/C Ratio: 6.3

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted improvement:

Bldg No.	SF Area	S or P*	Use
205	3,265	S	Office
215	1,820	P	Office
232	1,960	S	Service
302	5,457	S	Housing
303	5,452	S	Office
304	5,452	S	Office
305	5,452	S	Office
306	5,996	S	Office
307	5,996	S	Institutional
308	5,996	S	Institutional
309	5,996	S	Storage
409	800	S	Service
500	6,135	S	School
501	6,135	S	Housing
503	6,135	S	Housing
505	5,760	S	Institutional
611	1,840	S	Service
3021	6,733	P	Office
3520	4,000	S	R & D
3524	800	S	Service

*S=Semi-permanent, P=Permanent

Project to Install New Lighting Systems

A. Project Summary and Description

The buildings involved for this project have inefficient incandescent lighting systems. Three of the four buildings are storage facilities, where the need for artificial lighting is questionable. Even with the minimal use assumed, it will still be cost-effective to convert to energy-efficient fluorescent lighting, especially if the buildings will continue to be in use for 5 years or more.

B. Project Savings

1. Estimated Annual Dollar Savings: $3,658
2. Annual MMBTU Savings: 82
3. Simple Amortization Period (SAP): 5.4
4. B/C Ratio: 1.5
5. E/C Ratio: 4.1

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
1Ø2	4,Ø2Ø	S	Storage
1Ø3	4,Ø2Ø	S	Storage
1Ø4	4,Ø2Ø	S	Storage
3518	4,ØØØ	S	R & D

*S=Semi-permanent, P=Permanent

Project to Install Wall Insulation in Family Housing

A. Project Summary and Description

There are many houses at YPG of frame construction whose walls have poor insulating characteristics. Providing blown-in fiberglass or mineral wool insulation in these walls will greatly reduce heating and cooling loads by increasing thermal resistance.

Implementation of this project would require drilling holes in the stucco finish on family housing units and blowing fiberglass insulation into the wall cavities. The stucco would then have to be repaired and the entire building's exterior repainted. This method of providing insulation involves standard practices which can be accomplished by local contractors. Since only exterior construction is involved, no interruption of normal occupant routines is anticipated.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $39,362
2. Annual MMBTU Savings: 5868.4
3. Simple Amortization Period (SAP): 4Ø.1 years
4. B/C Ratio: Ø.4
5. E/C Ratio: 3.7

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Family Hsg. Unit Types	SF Area	S or P*	Use
3,A,C,H	19,4Ø2	P	Housing
D,E,F,G	66,738	P	Housing
7,I	116,934	P	Housing
1,2,4,5	75,726	P	Housing

*S=Semi-permanent, P=Permanent

Project to Install Exterior Roof Insulation

A. Project Summary and Description

Many buildings at YPG have roofs which are poorly insulated. Roof surfaces are also highly absorptive of solar radiation. Installation of a sprayed-on layer of urethane foam finished with a highly reflective coating would greatly reduce conductive heat loss/gain and radiative heat gain.

Implementation of this project requires the application of one inch of sprayed-on urethane foam insulation with a special reflective finish. For existing tar and gravel roofs, gravel must be removed and the surface prepared to receive the foam urethane. Since only exterior construction is involved, no disruption of normal occupant routines is anticipated.

B. Project Savings

1. Estimated Annual Dollar Savings: $2,Ø97
2. Annual MMBTU Savings: 277
3. Simple Amortization Period (SAP): 49.1 years
4. B/C Ratio: Ø.26
5. E/C Ratio: 2.7

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
404	5,527	S	Service
714	4,852	S	Office
2000	4,240	S	Office
2100	19,320	S	Office
3005	6,250	S	Service
3518	4,000	S	R & D
3586	400	S	Storage

*S=Semi-permanent, P=Permanent

Project to Apply Reflective Roof Coating

A. Project Summary and Description

The purpose of this project is to reduce solar heat gain through roofs by applying highly reflective roof coatings. The results show reduced cooling loads, but slightly increased heating loads. Since YPG is located in a climate where building cooling loads predominate, these findings are positive, both for energy savings and improved occupant thermal comfort. By applying a reflective acrylic roof coating (either sprayed or rolled-on), the absorptivity is significantly reduced and the roof is provided with a new waterproof membrane. This type of retrofit has the advantage of providing added comfort to semi-conditioned spaces (evaporative cooled).

B. Project Savings

1. Estimated Annual Dollar Savings: $267
2. Annual MMBTU Savings: 137.6
3. Simple Amortization Period (SAP): 213.2
4. B/C Ratio: -0.01
5. E/C Ratio: 2.4

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
6	5,400	S	Storage
101	4,314	S	Service
124	3,500	S	Off/Storage
404	5,527	S	Service
2090	16,465	S	R & D
2096	4,920	S	R & D

(cont'd on following page)

Bldg No.	SF Area	S or P*	Use
221Ø	7,2ØØ	S	R & D
349Ø N.	27,2ØØ	P	R & D
3556	4,ØØØ	S	R & D
51ØØ	4,ØØØ	S	Service

*S=Semi-permanent, P=Permanent

Project to Install Solar Energy DHW Heating Systems

A. Project Description

This project is designed to reduce energy consumption for domestic water heating. The project involves installation of active solar energy domestic hot water systems on 5 buildings. These buildings will be provided with solar collectors, control systems, pumps, insulated storage tanks, and associated plumbing and valves.

B. Project Savings

1. Estimated Annual Dollar Savings: $587
2. Annual MMBTU Savings: 8Ø.2
3. Simple Amortization Period (SAP): 49.7
4. B/C Ratio: Ø.48
5. E/C Ratio: 2.7

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
1Ø5	1Ø,156	S	Service
12Ø	8,3ØØ	S	Institutional
611	1,84Ø	S	Service
1ØØØ	8,ØØØ	S	School
349ØS	59,4ØØ	P	R & D

*S=Semi-permanent, P=Permanent

Project to Install Blown-In Insulation in Exterior Walls

A. Project Summary and Description

There are many buildings at YPG of frame construction whose walls have poor insulating characteristics. Providing blown-in fiberglass or mineral wool insulation

inside these walls could greatly reduce heating and cooling loads by increasing thermal resistance.

Implementation of this project would require one of two basic procedures depending on the construction of the particular building:

1. Wood frame buildings would have holes drilled in the stucco outer layer through which insulation would be blown into the wall cavity. The stucco would then have to be patched and much of the entire building exterior repainted.

2. Metal buildings with metal stud exterior wall framing would generally require partial removal and replacement of exterior metal sheathing to allow insulation to be blown in.

Both of these methods utilize standard practices which may be implemented by local contractors. Since only exterior construction is involved, no disruption of normal occupant routines is anticipated.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $2,112
2. Annual MMBTU Savings: 213
3. Simple Amortization Period (SAP): 42.5 years
4. B/C Ratio: 0.34
5. E/C Ratio: 2.4

C. Recommended Facilities

The following buildings have been selected and analyzed for the above-noted renovation:

Bldg No.	SF Area	S or P*	Use
205	3,265	S	Office
403	1,280	S	Storage
2075	8,012	S	Service
2091	1,200	S	R & D
2100	19,320	S	Office
2220	4,000	S	Office
2500	1,680	S	R & D
3007	1,200	S	R & D
3008	8,000	S	R & D
3010	6,000	S	R & D
3523	5,600	S	Other
3524	800	S	Service

*S=Semi-permanent, P=Permanent

3.4. ENERGY MONITOR AND CONTROL SYSTEMS (EMCS) PROJECTS

3.4.1. General Discussion

EMC investigated the potential for various types of Energy Monitoring and Control Systems (EMCS) for YPG. Starting with the existing radio controlled EMCS, EMC looked at various control strategies using different types of communication networks for buildings that are already connected to the EMCS and for buildings that are not. Various factors influenced the types of EMCS studies for this project and the reasons why other system types were rejected. These factors include:

1. Climatic considerations

   Yuma has one of the consistently hottest summer climates in the United States, where typical daily temperatures range from 85°F at night to 110°F in the afternoon.

2. Status of existing buildings

   Roughly 60% of the most frequently occupied administrative and service buildings are currently scheduled for demolition upon construction of new facilities to take their place. This work is part of the YPG Long Range Master Plan.

3. YPG regulations

   YPG regulations require 1) 24 hour space cooling of approximately 35 critical use and residential buildings and 2) space cooling systems be shut down for 6 months of the year (during the "winter" season). Occupant comfort understandably overrides the requirement for energy savings that comes from shutting down A/C units during the cooling season.

Aside from applicable control strategies (which are discussed later), the most critical item is the choice of a communications network for data transmission and reception of the EMCS control points. Due to the arrangement and status of most applicable buildings (as discussed above), it quickly became apparent that the cost of hardwiring to all buildings would be economically prohibitive. The only other potential distribution networks were radio transmission and existing telephone communication cables.

Two EMCS's using these latter types of communication network were investigated. Both alternatives for a centralized EMCS design configuration include start/stop

capabilities to satisfy various control strategies such as demand limiting, duty cycling, and time-clocked operations. Any additional control strategies such as ventilation, recirculation, and temperature resets are impractical at YPG because of the following reasons:

1. The cost of field panels to handle the necessary analog input/output for each building would be economically prohibitive based on the size, age, status, and number of loads that must be controlled.

2. Most centrally controlled buildings have direct expansion (DX) type package or split HVAC systems, single duct with no terminal reheat.

3. Installation of air economizer cycles and outside air (enthalpy) controls for all centrally controlled buildings with a 8-10 hour daily operation schedule is impractical based on Yuma climatic conditions and Army guidelines that specify a 6 month cooling season and because of the semi-permanent status of most buildings.

With regard to energy savings calculations for nighttime shut-off of HVAC equipment, base loads for buildings were calculated for 24 hr/day, 7 days/wk usage as this is how buildings were operated during the period used for loads verification; i.e., last 3 years of energy consumption records and as specified in Section 4.1.12 and 4.2.2.2. of the Scope of Work. It became apparent from our observations at YPG that for the last few months space cooling and heating systems have been manually shut down in various administrative buildings at the end of the working day. Since this method of equipment control offers a fairly low reliability factor as compared to a central EMCS control system with building status reports, energy savings calculations assumed that there would be no further manual system shut-down since assuming any other operating scenario would eliminate any potential energy savings.

3.4.2. Project to Upgrade Existing Energy Management Control System (EMCS)

A. Project Description

Field investigations suggest that the most economical and effective method of providing maximum control of existing facilities would result from upgrading the existing EMCS with a more sophisticated and functional central processing base station. After expansion, the primary control strategies would include:

- o Demand limiting
- o Timeclocked start/stop
- o Duty cycling

Motorola, manufacturers of the existing radio-controlled EMCS, provided detailed information (including cost estimates) about a new load management controller. The ESC-400 Motorola Load Management Controller is compatible with the existing Model 800W radio switches already located at each controlled load. The ESC-400 provides for <u>all</u> of the three primary control strategies listed above.

Upgrading the existing system will require replacement of the existing Q2043 Load Management Base Station with the ESC-400 Series System Controller. This controls package includes:

- o Microcomputer mainframe,
- o CRT/keyboard,
- o Dual floppy disk,
- o Printer,
- o Standard load management software, and
- o System desk

To control the nighttime start/stop operations of heating systems in winter, an additional Model 800W radio switch must be installed at each load.

The ESC-400 Series System Controller performs three types of control for load-shedding functions which can be selectively used for varying degrees of demand limiting, duty cycling, and timed start/stop of both space cooling and heating systems.

B. Project Savings

1. Estimated Annual Dollar Savings: $ 114,562
2. Annual MMBTU Savings: 9,775
3. Simple Amortization Period (SAP): .6
4. B/C Ratio: 16.9
5. E/C Ratio: 137.8

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

The following space cooled and heated buildings are currently being controlled by the existing EMCS and have also been selected for upgrading:

(see following page)

Bldg No.	SF Area	S or P*	Use**	Point Count	Cooling Savings (MMBTU)	Heating Savings (MMBTU)
2	14000	S	O	1	580.3	82.4
101	4314	S	SE	1	67.2	194.9
120	8300	S	I	2	579.7	107.9
205	3265	S	O	2	121.9	28.1
215	1820	P	O	2	74.6	21.2
226	1144	P	HI	2	52.0	19.3
232	1960	S	SE	2	136.9	23.9
301	1764	S	SE	2	105.1	29.6
302	5457	S	O	3	227.1	53.8
303	5452	S	N	2	192.6	48.6
304	5452	S	O	2	196.3	48.9
305	5452	S	O	2	196.1	56.5
307	5996	S	I	2	230.3	62.1
400	3222	S	O	2	75.9	23.1
402	3640	S	O	3	124.9	28.5
451	7260	P	SE	3	-	-
452	1575	S	O	2	58.6	14.6
500	6135	S	SC	2	160.5	57.2
501	6135	S	HO	2	-	-
503	6135	S	HO	2	-	-
504	16091	S	SE	2	500.0	180.1
505	5760	S	I	2	183.5	94.6
515	6080	S	I	2	658.2	108.7
518	10701	S	SE	2	103.2	184.3
530	12700	P	I	2	272.6	160.3
611	1840	S	SE	2	175.6	117.7
701	1750	S	O	2	64.6	11.3
702	5382	S	O	2	173.9	32.6
714	4852	S	O	3	244.2	35.9
1000	8000	S	SC	2	400.3	138.4
1001	7415	S	I	2	106.9	22.8
1003	6490	S	HO	2	-	-
1004	21600	P	HO	2	-	-
1100	10880	P	I	2	503.5	101.3
1220	1712	P	HI	2	74.8	34.3
2000	4240	S	O	2	95.3	32.2
2090	16465	S	RD	2	154.3	124.9
2210	7200	S	RD	2	68.3	24.3
2220	4000	S	O	2	72.1	13.5
3015	13200	P	RD	2	132.2	100.7
3022	6120	P	SE	2	234.1	97.5
TOTAL	271,000			84	7397.6	2377.6

*S=Semi-permanent, P=Permanent

**O=Office, C=Computer, SC=School, HO=Housing, SE=Service, I=Institutional, RD=Research & Development, HI=Hospital, N=Unoccupied

3.4.3. ECIP Project to Install New Energy Management Control System (Telephone Line Communication)

A. Project Description

This system will control the start/stop function of all load points to turn all HVAC equipment off during unoccupied hours and detect the on/off status of each load point from a central location. Within this context, each point can be controlled for demand limiting, duty cycling, and start/stop time-clocked operations. In addition, emergency shutdown of loads can be accomplished for peak summer loading emergencies.

System Description

The recommended EMCS consists of the following:

- o Central processing unit (CPU) with peripherals,
- o Remote field panels,
- o Communication network to remote field panels
- o Communication link between remote field panels and the device being controlled (i.e., the load), and
- o Interposing relay at each load.

Exhibit 11 is a block diagram which shows the relationship between and interaction of the various components.

Central Processing Unit

The CPU is a microcomputer which makes control decisions and communicates with the remote field panels. Associated with the central processing unit are peripherals which can include a cathode ray tube (CRT) display with input/output keyboard, disk storage, and printer.

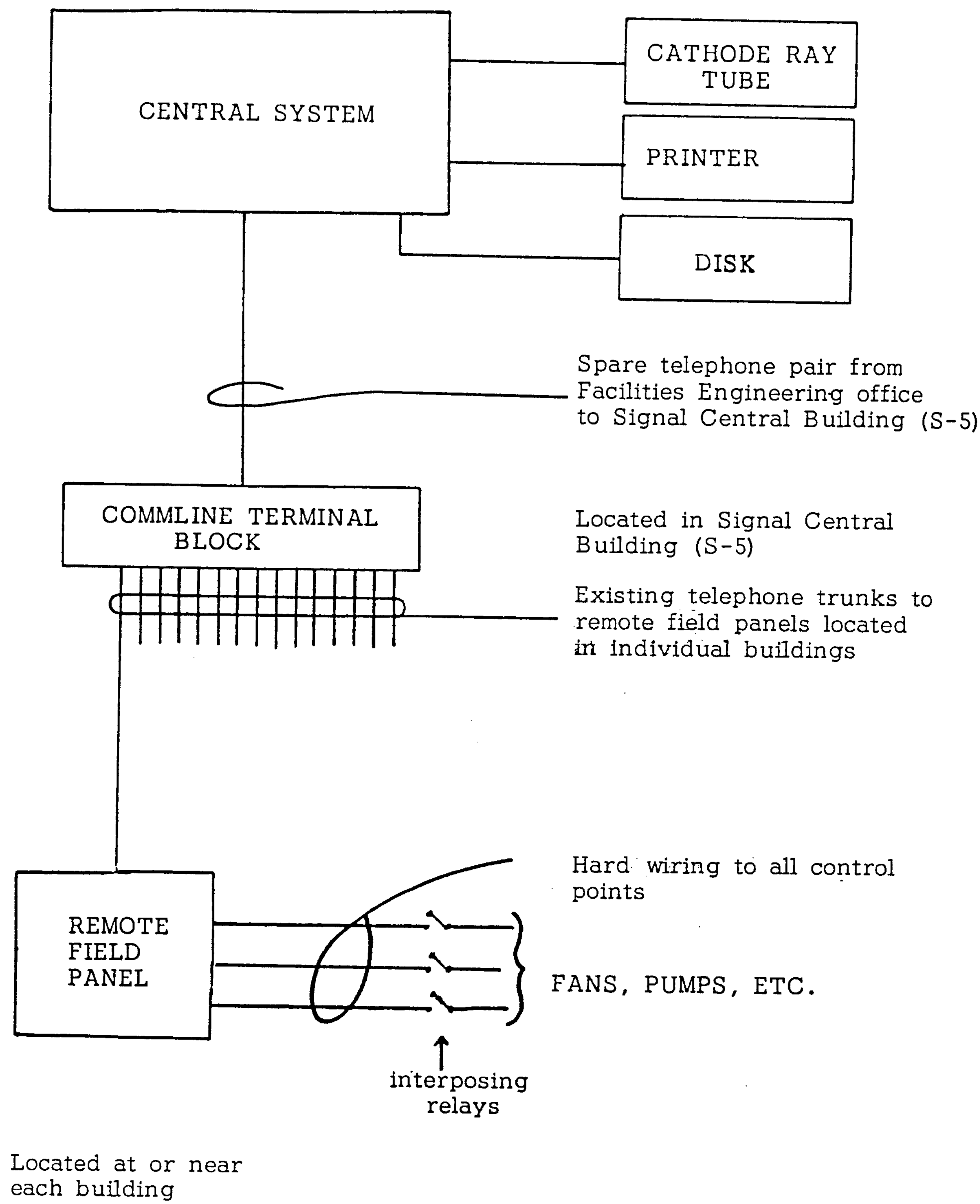
Communication Network

The communication network between the CPU and the remote field panels is the physical communication link that distributes information to and from all buildings at YPG.

Communications

The extensive telephone communications network at YPG should be suitable for the desired purposes with some minor modifications as needed. Each building requires the continuous clear use of two telephone pairs (to transmit and receive) that terminate at the central station. The most logical and least expensive location for the central station would be in or near the Telephone

Exhibit 11. ENERGY MONITORING AND CONTROL SYSTEM BLOCK DIAGRAM



Exchange Building (S-5) since all telephone pairs terminate here. The need to trench additional cable would be minimized.

Remote Field Panels

The 54 remote field panels which would be located throughout YPG monitor and control all functions, schedules, and control strategies, and can handle any combination of point types as specified on the point list These panels multiplex all input data from the actual field conditions and send this information back to the CPU via the communications network described above. In addition, the CPU transmits control information back to the remote field panels which in turn controls the status of the appropriate loads.

In general, the remote field panels act as the control interface between the CPU and the various loads located at or near a specified area.

Communication Link

Communication between the field panels and the loads will be provided by "hard" wiring through conduit as needed.

Interposing Relays

Each load will be turned on or off by an interposing relay located between the existing load controls and the load side of the communication line between the field panel and the load.

B. ECIP Savings

1. Estimated Annual Dollar Savings: $ 114,562
2. Annual MMBTU Savings: 9,775
3. Simple Amortization Period (SAP): 5.1
4. B/C Ratio: 2.0
5. E/C Ratio: 16.7

All buildings will be in active use throughout the amortization period.

C. Recommended Facilities

All facilities which are currently being controlled by the existing EMCS are immediate candidates for expanded control functions. Expanded control functions would not be applicable to twenty-four-hour, constant temperature, and critical temperature buildings as well as buildings with the equivalent of window air conditioners. The proposed central processing unit can handle any future

expansion indicated in the current YPG basewide master plan.

The following buildings have been selected to be included in the central EMCS:

Bldg No.	SF Area	S or P*	Use**	Point Count	Cooling Savings (MMBTU)	Heating Savings (MMBTU)
2	14000	S	O	1	580.3	82.4
5	6230	P	C	2	-	-
101	4314	S	SE	1	67.2	194.9
105	10156	S	SE	2	-	-
106	1250	P	SE	2	-	-
120	8300	S	I	2	579.7	107.9
205	3265	S	O	2	121.9	28.1
215	1820	P	O	2	74.6	21.2
226	1144	P	HI	2	52.0	19.3
232	1960	S	SE	2	136.9	23.9
301	1764	S	SE	2	105.1	29.6
302	5457	S	O	3	227.1	53.8
303	5452	S	N	2	192.6	48.6
304	5452	S	O	2	196.3	48.9
305	5452	S	O	2	196.1	56.5
307	5996	S	I	2	230.3	62.1
400	3222	S	O	2	75.9	23.1
402	3640	S	O	3	124.9	28.5
451	7260	P	SE	3	-	-
452	1575	S	O	2	58.6	14.6
500	6135	S	SC	2	160.5	57.2
501	6135	S	HO	2	-	-
503	6135	S	HO	2	-	-
504	16091	S	SE	2	500.0	180.1
505	5760	S	I	2	183.5	94.6
515	6080	S	I	2	658.2	108.7
518	10701	S	SE	2	103.2	184.3
530	12700	P	I	2	272.6	160.3
611	1840	S	SE	2	175.6	117.7
701	1750	S	O	2	64.6	11.3
702	5382	S	O	2	173.9	32.6
712	4080	S	C	2	-	-
714	4852	S	O	3	244.2	35.9
990	10200	S	HI	2	-	-
1000	8000	S	SC	2	400.3	138.4
1001	7415	S	I	2	106.9	22.8
1003	6490	S	HO	2	-	-
1004	21600	P	HO	2	-	-
1100	10880	P	I	2	503.5	101.3
1220	1712	P	HI	2	74.8	34.3
2000	4240	S	O	2	95.3	32.2
2090	16465	S	RD	2	154.3	124.9
2100	19320	S	O	2	-	-

(cont'd on following page)

Bldg No.	SF Area	S or P*	Use**	Point Count	Cooling Savings (MMBTU)	Heating Savings (MMBTU)
2210	7200	S	RD	2	68.3	24.3
2220	4000	S	O	2	72.1	13.5
3015	13200	P	RD	2	132.2	100.7
3021	6733	P	O	2	-	-
3022	6120	P	SE	2	234.1	97.5
3490N	27200	P	RD	3	-	-
3490S	59400	P	RD	3	-	-
3493	3296	P	RD	2	-	-
3519	6000	S	RD	2	-	-
3520	4000	S	RD	2	-	-
3523	5600	S	-	2	-	-
6071	48384	S	RD	3	-	-
TOTAL	482,805			115	7397.6	2377.6

*S=Semi-permanent, P=Permanent

**O=Office, C=Computer, SC=School, HO=Housing SE=Service, I=Institutional, RD=Research & Development, HI=Hospital, N=Unoccupied

3.5. INCREMENT F PROJECTS

3.5.1. General Discussion

Results of the EEAP analysis for Increment F include the development and analysis of maintenance, repair, and upgrade projects that are within the Facilities Engineer funding authority. These projects are divided into three basic categories and are presented in this section.

Section 3.5.2 contains the summary sheets for 18 project categories for 134 total projects that were analyzed. Included in the summary is the appropriate project description. Energy savings are presented for <u>each</u> building and for the total of all buildings <u>within a</u> project category. Certain projects do not include energy saving calculations because they could not be accurately modelled. Nonetheless, cost estimates were developed since in many cases these were substantial. Discretion should be used in selecting these projects for implementation.

To facilitate efficient implementation of projects, all backup information including detailed cost estimates, energy calculations and customized descriptions are presented in Appendix A as a package for each building.

Section 3.5.3 includes the analysis of projects that require major modifications and cost $50,000 or more.

Section 3.5.4 includes a list of miscellaneous minor maintenance items that were observed during EMC's field trips to YPG. These items are recommended for immediate action, but no energy savings or cost estimates were developed.

3.5.2 General Projects

Project: Reduce DHW Delivery Temperature

Locations: Main Base

Description of Modifications: Adjust heat exchanger controls to lower the delivered temperature of domestic hot water.

Reasons for Modification: These buildings store and deliver hot water at approximately 140°F, causing unnecessarily high conductive heat losses through storage tank walls and piping.

Instructions for Modification: Boiler maintenance personnel should adjust the thermostatic valve which controls the flow of steam through the DHW heat exchanger so that the temperature of water stored will be lowered 20°F from 140°F to 120°F.

Conclusion: This project should be pursued as it results in large energy savings for a very small initial investment.

Energy Analysis:

Energy Saved/Yr (MMBTU)	Dollars Saved/Yr	Payback Years	E/C
173.88	1718	.02	4830

Project: Install Automatic Lighting Fixture Controls

Locations: Main Post, Mobility Test Directorate

Description of Modification: Install special light controls for infrequently used areas of the building.

Reasons for Modification: These buildings each have rooms which, although used only occasionally, are kept lit continuously over the working day.

Instructions for Modification: Remove existing light switches in these rooms and replace them with sound-sensing switches. Adjust new switches to sense human footsteps so that they turn off within one minute of sensing total silence (see Appendix B-96 for product information).

Conclusion: This project should be implemented immediately due to the short payback period and large E/C.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
97.7	380	396.00	1.0	265.1

Project: Install Automatic Vent Dampers

Locations: Main Post

Description of Modification: Install automatic vent dampers in boiler chimneys to close off flues when boilers are off and venting is not needed.

Reasons for Modification: Presently, super-heated air is wasted as it escapes through undamped chimneys. This condition causes the boilers to consume excess energy in meeting any given load.

Instructions for Modification: Cut into the chimney beyond the barometric diverter, removing a section of the existing chimney just large enough to install the round shaft of the automatic damper. Wire the motor to the actuator in series and the power source in parallel, setting up a series/parallel circuit. (See Appendix B-86 for product information).

Conclusion: This project should be implemented as soon as possible since this item has a very long life and it is a low maintenance item of equipment.

Energy Analysis:

505.9	2470	4988.00	2.0	204.1
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C

Project: Isolate Building Zones -

Locations: Main Post

Description of Modification: Insulate and seal interior thermal barriers between conditioned and unconditioned building zones and modify HVAC equipment to allow for total shutdown of unconditioned zones.

Reasons for Modification: These buildings each have areas which are used only occasionally but, at present, are fully conditioned because they cannot be thermally isolated from zones which require conditioning. Isolating these areas would considerably lower energy consumption.

Instructions for Modification: Refer to specific instructions for each building.

Conclusion: This project should be implemented because of the very short payback period.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
578.20	4030	3053.43	1.3	143.0

Project: Insulate Refrigerant Suction Piping

Locations: Main Post, Mobility Test Directorate

Description of Modification: Replace deteriorated insulation on refrigerant suction lines. Install insulation if none exists.

Reasons for Modification: Poorly insulated or uninsulated refrigerant suction piping in an unconditioned area (with temperature ranges of $75^{\circ}F$ to $115^{\circ}F$) causes condensation, unnecessary heat gain to the refrigerant, and, thus, lowered operating efficiency of space cooling systems.

Instructions for Modification: Remove existing insulation if deteriorated and replace with new insulation that is vapor sealed to prevent moisture from traveling through the insulation and condensing on piping. (See Appendix B-135 for product information).

Conclusion: This project should be implemented due to the short simple payback time, low maintenance, and 5 to 8 year life of the insulation.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
55.4	465	224.58	2.1	119.2

Project: Install Natural Daylighting Roof Panels

Locations: Mobility Test Directorate

Description of Modification: Remove 10 - 8'x4' corrugated metal sheets from the roof and replace them with 10 - 8'x4' translucent corrugated fiberglass panels.

Reasons for Modification: This building has a large welding shop which requires a low ambient lighting level over a large area. At present, lighting is provided by 20 - 328 watt fluorescent fixtures. With only minor modifications, lighting could be provided by daylight.

Instructions for Modification: Remove 10 evenly spaced 4'x8' corrugated steel roof panels over the welding shop area and replace them with translucent corrugated panels. Seal panel edges and fasteners with silicone or other appropriate sealant.

Conclusion: This project should be implemented immediately due to the short payback period and large E/C ratio.

Energy Analysis:

137.70	1420	558.00	2.5	97.2
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C

Project: Rewire Switching for Light Fixtures

Locations: Main Post, KOFA Firing Range

Description of Modifications: Rewire switching for lighting fixtures in numerous office and research buildings.

Reasons for Modification: These buildings have large areas of lighting which must be left on constantly because the switching layout requires that all lighting be left on even when only a small area is in use.

Instructions for Modification: Rewire lighting fixture controls to provide a separate switch for each room or, in larger rooms, for each task area as described.

Conclusion: This project should be pursued immediately because it has a short payback and high E/C ratio.

Energy Analysis:

387.0	6576	1567.00	5.2	47.4
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollar Savings/Yr	Payback Years	E/C

Project: Insulate Boiler Casings

Locations: Main Post, KOFA Firing Range

Description of Modification: Boiler casings are presently insulated with only 1" of fiberglass. This project will improve the insulation value by adding 2" of spray foam insulation and providing a protective covering.

Reasons for Modification: Insulation is inadequate and large stand-by losses occur, especially during low load periods, such as in the summer when boilers are used for DHW heating only.

Instructions for Modification: Mask-off valving, thermometers and access ports. Spray on 2" of spray foam insulation covered by a fireproof coating.

Conclusion: This project should be implemented because of the short payback time and because little maintenance is required.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
158.85	3500	1566.24	2.3	44.7

Project: Install Timeclock on Exhaust Fans

Locations: Main Post

Description of Modification: Install a time clock on the power box for bathroom exhaust fans in the New Wing of Building 5Ø6.

Reasons for Modification: The New Wing of the E.M. Barracks, Building 5Ø6, has 18-1/12 H.P. exhaust fans which run 24 hours a day to ventilate bathrooms. The ventilation provided by the fans is excessive and could easily be reduced to half of its present level. Installation of a time clock to cycle these fans on and off would significantly reduce energy use both by the fans themselves and the HVAC systems which must condition excessive makeup air.

Instructions for Modification: Install a 24-hour timeclock to control the power supply to all bathroom exhaust fans. Fans should be turned off during hours of minimum occupancy; e.g., when personnel are at work. We do not suggest cycling fans less than once an hour as this could significantly decrease fan life. Calculations assume 12 hours per day operation instead of 24 for a 5Ø% reduction in energy use by the fans themselves.

Conclusion: This project should be pursued immediately because it has a short payback and high E/C ratio.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollar Saved/Yr	Payback Years	E/C
93.7	218Ø	39Ø.ØØ	5.6	43.Ø

Project: Improve Insulation for Ductwork and Air Handlers

Locations: Main Post, Mobility Test Directorate

Description of Modifications: Apply external insulation to air handlers and supply air ductwork in unconditioned spaces.

Reasons for Modification: Conditioned air traveling through uninsulated air handlers and ductwork in unconditioned spaces increases heat loss/heat gain for HVAC systems. Applying external insulation will greatly reduce these heat losses and gains.

Instructions for Modification: Install a minimum of 1" of fiberglass insulation covered with a field-applied multi-layer vapor barrier for either indoor or outdoor application, as appropriate.

Conclusion: This project should be implemented for the buildings that will be used longer than the payback time.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
271.ØØ	9,1ØØ	1475.ØØ	6.2	29.8

Project: Replace Ballasts in Flourescent Lighting Fixtures

Locations: Main Post, M.T.D., L.A.F., KOFA

Description of Modification: Remove existing ballasts and replace with energy efficient ballasts.

Reasons for Modification: The replacement of a standard ballast with an energy efficient ballast reduces the energy consumed by the ballast and the input wattage of the lamp.

Instructions for Modification: Remove lens, lamps and ballast cover. Install new energy efficient ballasts, and replace existing lamps and lenses. (See Appendix B-53 to B-55 for product information).

Conclusion: The simple payback for replacing ballasts all at once is slightly less than the life of an energy efficient ballast. Nevertheless, this project should still be implemented. In the alternative, existing ballasts should be replaced with energy efficient ballasts as they burn out.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
427.1	30,040	1729.81	17.4	14.2

Project: Install Insulated Roll-Down Doors

Locations: Mobility Test Directorate, KOFA Firing Range

Description of Modification: Remove existing metal roll-down doors and replace them with foam-insulated roll-down doors.

Reasons for Modification: Standard uninsulated metal roll-down doors provide little resistance to thermal conduction and are also highly absorptive of solar radiation. Foam-insulated rolldoors now commercially available combine good thermal resistance characteristics with a highly reflective surface that will considerably reduce transmission of thermal energy. This results in lower heating and cooling loads for buildings where they are installed.

Instructions for Modification: Remove existing metal roll-down doors and replace them with new foam-insulated roll-down doors. Most of the existing door hardware (rails, springs, etc.) can be retained. (See Appendix B-131 for product information).

Conclusion: This project should be pursued because it both decreases energy consumption and increases occupant comfort.

Energy Analysis:

104.34	7340	533.58	13.7	14.2
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C

Project: Shutdown Boiler/Install New DHW Heater

Location: Main Post

Description of Modification: Shut down boilers except during the heating season and install smaller DHW heaters for hot water loads that were previously satisfied by boilers.

Reasons for Modification: Large hot water boilers are presently being operated inefficiently at part load to supply very small DHW loads during the summer season when there is no space heating load.

Instructions for Modification: Install boiler by-pass valve and separate electric DHW heater. (See Appendix B-60 to B-75 for product information).

Conclusion: This project should be implemented because it results in a simple payback of less than 10 years for proposed equipment that has an expected life of 15 to 20 years.

Energy Analysis:

11.358	1050	112.00	9.4	10.8
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C

Project: Upgrade Circulation Pumps with More Efficient Motors.

Locations: Main Post, Mobility Test Directorate, KOFA Firing Range.

Description of Modification: Replace old existing circulation pump motors with high-efficiency motors.

Reasons for Modification: Significant advances have been made in electric motor design over the past few years. State-of-the-art high-efficiency motors consume considerably less energy at a higher power factor than standard electric motors.

Instructions for Modification: Remove existing circulation pump motors and replace them with new high-efficiency motors. (See Appendix B-118 to B-120 for product information).

Conclusion: This project should not be pursued immediately for all motors because the payback period is too long but rather on an as-needed basis as motors wear out.

Energy Analysis:

18.5	2565	75.00	34.2	7.2
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C

Project: Improve Window Shading

Locations: Main Post, KOFA Firing Range

Description of Modification: Install solar shade screens on glazing.

Reasons for Modification: Even though all of these buildings have some form of window shading, energy use could still be further reduced and occupant comfort increased markedly by installing solar shade screens. In the recommended applications, use of shading would eliminate the annoyance which results from the entry of direct sunlight into working areas.

Instructions for Modification: Install solar screens within existing window frames on all eastern, southern, and western glazing exposures. (See Appendix B-141 for product information).

Conclusion: This project shows insufficient return on investment and is therefore not recommended.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
47.1	6670	209.00	31.7	7.1

Project: Replace Cooling Equipment

Locations: Main Post, Mobility Test Directorate

Description of Modification: Replace old, inefficient equipment with newer, more efficient equipment without reducing the capacity of the system below that necessary to handle the existing cooling load.

Reasons for Modification: These cooling systems are generally oversized, and the air-cooled condensing units are very inefficient.

Instructions for Modification:

1. Remove existing condensing units and replace with smaller more efficient units utilizing existing compressor and air handler.

2. Remove existing package unit and replace with a split system, installing a new air handler (See Appendix B-1 for product information).

Conclusion: The simple payback on this project is very long but salvage value or reuse of oversized systems has not been taken into account. Consider implementing this project on a building by building basis.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
151.35	29,470	612.98	48	5.1

Project: Improve Air Distribution

Locations: Main Post, M.T.D., KOFA, C.D.A.

Description of Modifications: This project involves improvements to supply and return air distribution. In most cases these projects will improve the overall performance of heating and cooling systems as well as thermal comfort for occupants.

Reasons for Modification: In most cases one part of a building is usually warmer or cooler than the rest. Implementation of these projects will help balance air distribution for the entire building.

Instructions for Modification:

1. Install supply air balancing dampers.
2. Install supply air ducts and registers.
3. Increase return air duct size.

Conclusion: The implementation of these projects will involve high first costs but will be cost-effective if the buildings are to be fully utilized. Discretion should be used in selecting projects for implementation since energy savings in many buildings cannot be precisely determined.

Energy Analysis:

1129	115,400	5674	Note 1	Note 1
Energy Saved/Yr (MMBTU)	First Cost ($)	Dollar Saved/Yr	Payback Years	E/C

Note 1: Energy savings were not calculated for most of these projects because of the undefined future use of the buildings and the lack of information on which modifications to individual buildings will actually be implemented.

Project: Modify HVAC Controls

Locations: Main Post, Castle Dome Annex

Description of Modification: Project includes:

1. Improve thermostatic controls.
2. Improve zone control capabilities.
3. Improve economizer systems.
4. Install time clocks.

Reasons for Modification:

1. Provide set-back/set-up capabilities.
2. Motors have been removed, damper drives are disconnected or missing.
3. Buildings with more than 8 hour (daytime) use have potential for free cooling.
4. Operation of chilled water systems is presently unscheduled.

Instructions for Modification:

1. Install thermostats with set-back/set-up capabilities.
2. Install "Modutrol" motors on zoning dampers.
3. Install or repair motors and damper drives for OSA control.
4. Install and wire time clock to chiller and circulation pumps.

Conclusion: Improvement of controls is necessary and should be performed regardless of the energy savings to reduce the cost of equipment maintenance. In addition, effective operation of HVAC controls is necessary to realize energy savings from any other recommended energy conservation projects.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
--	61,800	--	--	--

3.5.3 Major Modification Projects

Project: Install Computerized Programmable HVAC Control System

Locations: Building 5Ø6

Description of Modification: Provide flexible and comprehensive control of chilled and hot water distribution throughout all three wings, taking maximum advantage of occupancy schedules, building characteristics and time of day to minimize electrical demand during peak periods and to reduce overall energy consumption throughout the year.

Reasons for Modification: There is currently a study being performed by an A/E firm to determine the most effective method of repairing the mechanical problems that exist in Building 5Ø6. After reviewing the problems indicated in this study, the most effective improvement would appear to involve connecting the main "Centravac" chiller to provide cooling for the entire building. The other A/E firm is in the process of developing cost estimates and performing energy analysis for this project. Given this proposed system improvement, a comprehensive strategy to properly control this system and provide maximum energy efficiency is strongly recommended.

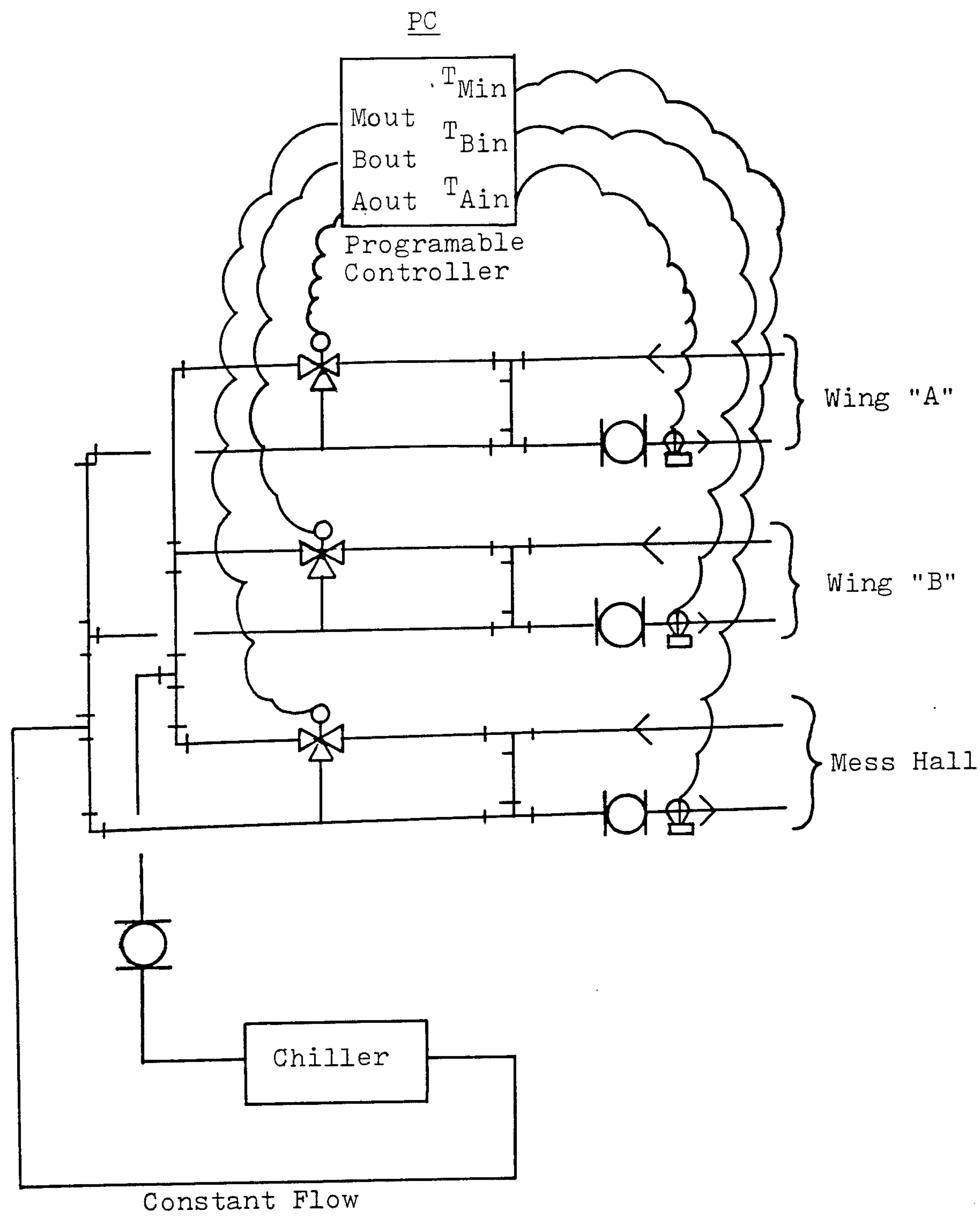
Instructions for Modification: A programmable controller (PC) will control demand and energy consumpton by cycling chilled and hot water to the three wings (Old, New, Mess Hall). The chilled water distribution system will utilize in-line pumps and control valves arranged in a primary/secondary configuration that would allow modulation control of each wing (see Exhibit 12). Chilled water temperatures would be gradually reset in each wing to shave peaks and suit the other energy management needs of the facility; for example:

- o Mess Hall temperature would be set up during working but non-occupied hours, and air conditioning shut off completely during non-working, non-occupied hours.
- o The old and new wing chilled water temperatures would be reset in accordance with solar loading, time of day, and prescribed schedules.

To produce the necessary savings, the PC will be specified to include the following controls as a minimum:

- o Cooling Tower fans at wet bulb approach
- o Chiller at required capacity to serve the three zones

Exhibit 12. PROPOSED PRIMARY/SECONDARY CHILLED WATER FLOW CONFIGURATION



- o Control of three zones as individual loads dictate
- o Hot water supply temperature for heating reset to outside air

In addition the following modifications will be necessary:

Chiller - Change control to proportional integral (PI) type to eliminate proportional offset.
- Put in chiller control point adjust (CPA) for reset.

Cooling Tower - Revise fan sequencing to allow 1 on, 2 on, or none on. Put auto control loop in PC.

Air Handling Units - YPG will repair economizer controls, remove hot water and chilled water control valves, repair and calibrate zone controls (dampers and thermostats).

Mess Hall - Revise unit controls and fan dead band control.

- Install 2 speed motors on AHU's and kitchen fans.

- Install "Vari-Cool" type kitchen make-up unit to offset cooling system load imposed by kitchen exhaust

- Install direct/indirect cooling "Vari-Cool" on main air handler to reduce refrigeration load

Conclusions: Although this project has a low E/C ratio (9.2), there are additional benefits that will accrue from its implementation. As a major peak demand user, properly planned control of this building can realistically keep YPG below the peak demand limit of which they must purchase an additional $90,000 block of electricity.

It is recommended that this project be seriously considered as an integral part of the overall upgrading of the HVAC systems in Building 506.

Energy Analysis:

Energy Saved/Yr (MMBTU)	First Cost ($)	Dollars Saved/Yr	Payback Years	E/C
505	55,000	2045	27	9.2

Project: Improve Air Distribution

Locations: Building 3490

Description of Modification: Eliminate air stratification and wasted heating/cooling in 27,000 square feet of 40 foot high space by retrofitting the air distribution ducting.

Reason for Modification: Building 3490 is one of the largest air conditioned buildings at YPG. The 40 foot high ceiling, with supply registers at the 35 foot level and return registers at the 14 foot level, results in energy-inefficient space heating and cooling at the 0 to 10 foot level where occupants and machinery are located.

The proposed modification will provide excellent space conditioning at the 0 to 10 foot level, while creating a stratified air "barrier" above the 10 foot level. Effectively, only the space below 10 feet would be conditioned, eliminating more than half of the volume that is currently being conditioned and reducing the load by almost as much.

The proposed modification will also accommodate the periodic use of the crane, necessary to move heavy machinery and equipment.

Instructions for Modification: The proposed modification requires two tasks to achieve the desired energy savings:

1. Installation of 27 flexible, ribbed boots in each of the existing supply ports, placement of supply registers at the ends of these supply boots, and installation of a motorized device to raise and lower the supply ducts. One switch would control each set of nine supply ducts. The registers would terminate approximately 10 feet from the floor and would be raised to their original height when the crane is used (see Exhibit 13).

2. Modification of the three existing air handlers to accommodate return air from floor level by altering the existing return air/outside air intake (see Exhibit 14).

Conclusion: Although this project has a fairly low E/C ratio (10.6), it is recommended for serious consideration since the calculation of energy savings was quite conservative. To

Exhibit 13. PROPOSED SUPPLY AIR RETROFIT FOR BLDG. 3490

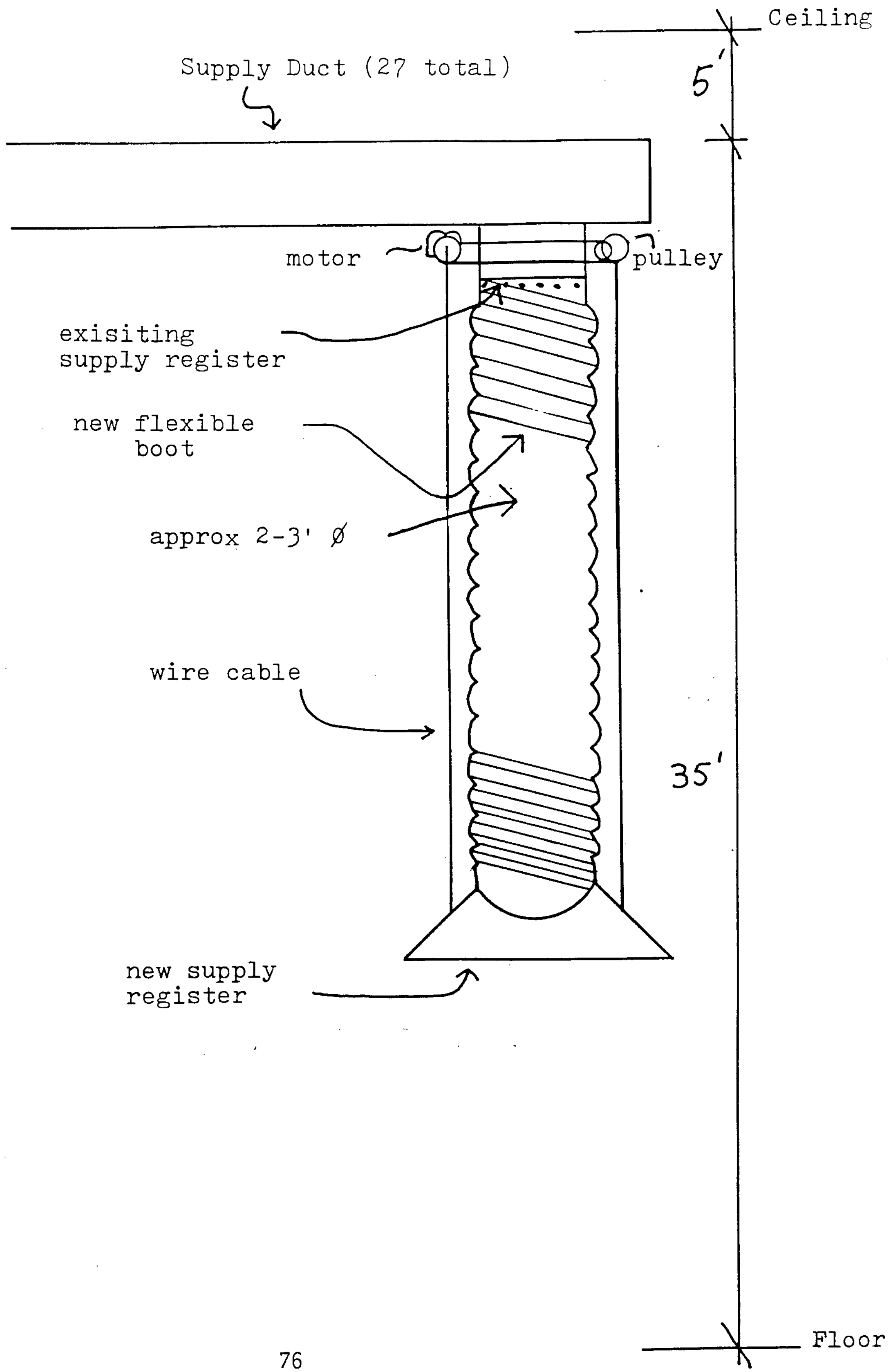
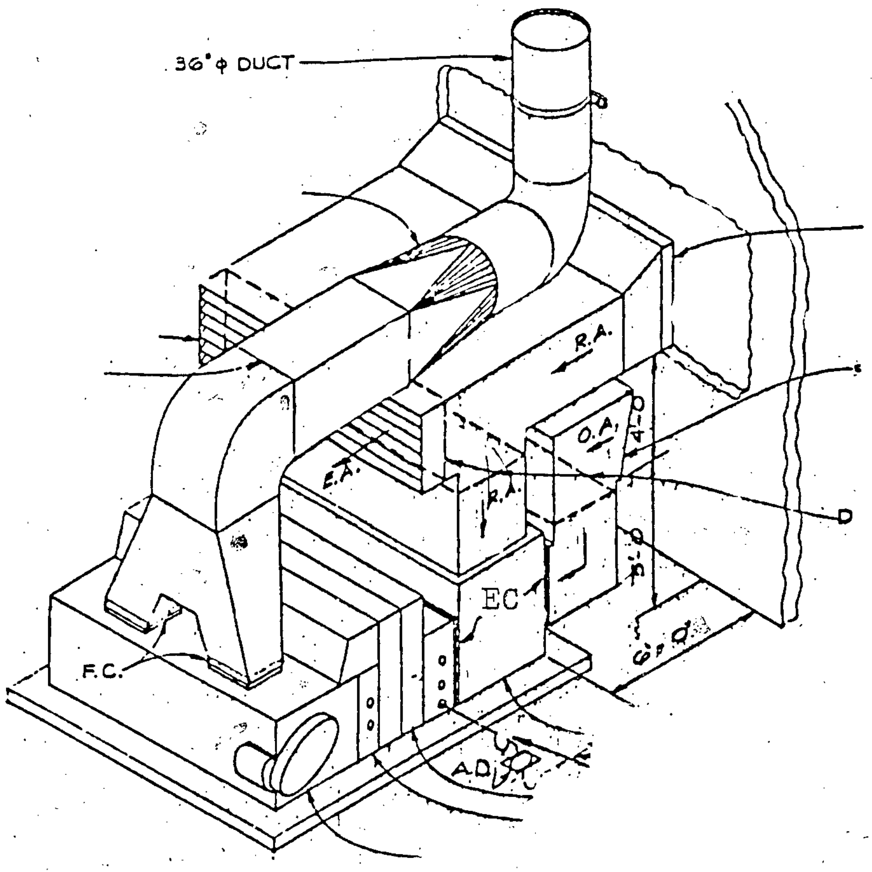
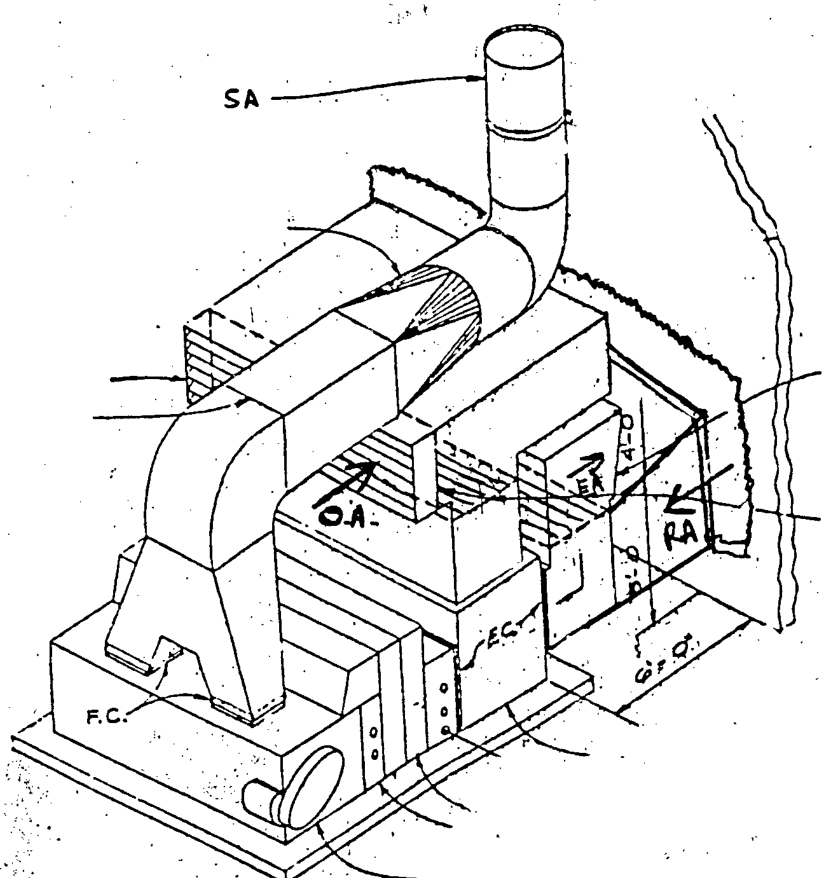


Exhibit 14. Proposed Air Handler Retrofit for Bldg. 3490



Exisiting Air Handler



Air Handler With Proposed Changes

properly model the physical situation would have required extensive computer analysis beyond the scope of this study. It is anticipated that actual energy savings would be greater, thus making it more attractive.

Energy Analysis:

Energy Saved/Yr MMBTU	First Cost	Dollars Saved/Yr	Payback Years	E/C
606	57020	3555	16.0	10.6

3.5.4. Minimum Maintenance Projects

Bldg. No.	Minimum Maintenance Items
5	o Adjust thermostat controlling main O.S.A. damper to approximately 75° F, presently set at 50° F. o Repair electrostatic air cleaner
120	o Lower boiler set point temperature during non-heating season; presently supplies 150° F domestic hot water o Raise thermostat setting for lunch room cooling system; presently maintains interior temperature around 68° F
205	o Replace return air filter o Raise thermostat setting for cooling system; presently set at 73° F
301	o Clean ductwork
304	o Install supply air slide damper on forced air furnace to prevent backflow of cool air into the mechanical room during the cooling season
307	o Clean condenser coil
400	o Clean condenser coil
402	o Clean ductwork
451	o Repair condenser fan motor o Repair leaks in pneumatic control lines
505	o Clean condenser coil
518	o Lower boiler set point temperature from 150° F to 120° F
611	o Repair fan in air handler
712	o Move fluorescent fixture in the room that is located in the southeast corner of the building to allow free air flow from supply register
714	o Clean ductwork o Clean condenser coil on Carrier unit o Clean return grille behind machinery in north wing
990	o Replace air filters o Repair electrostatic air cleaner on west side of building

1000	o	Replace return air filter
1001	o	Close off or control O.S.A. damper for office cooling unit
	o	Investigate cool air being exhausted from attic vents
1220	o	Clean condenser coil
2060	o	Bolt down loose compressor
2096	o	Clean condenser coil
2105	o	Paint skylight wells white, for improved utilization of daylight
3008	o	Repair bent evaporative cooler water jets
3482	o	Repair expansion valve (1 of 4) which continually opens and closes
3566	o	Repair walk-in cooler
6004	o	Repair refrigeration problems; suction line iced all the way back to compressor crankcase

4.Ø. SUMMARY OF DOCUMENTED RECOMMENDATIONS

4.1. GENERAL DISCUSSION

Exhibit 2 summarizes all Increment A, B, and G projects according to ECIP criteria. In addition, Exhibit 3 summarizes all Increment F projects studied. The various projects have been evaluated and are discussed in Sections 4.2, 4.3, and 4.4. The resultant energy reductions which could be expected upon implementation of the selected ECIP, Increment G, and Increment F projects are discussed in Section 4.5.

4.2. INCREMENT A AND B ECIP PROJECT RECOMMENDATIONS

The Increment A and B Projects documented in Section 3.2 cover a variety of applications varying from improvement of building envelopes and system controls to the recommended use of solar energy for domestic water heating. One project is specifically designed for the family housing section (nighttime setback of thermostats) while the remaining projects are for all types of buildings at YPG.

The nature of the ECIP projects recommended suggests a logical procedure for their implementation to insure that the maximum energy savings can be realized.

There is one project that meets ECIP criteria but which is <u>not</u> currently recommended for implementation. This is the installation of a new EMCS (Section 3.5.3). It is our opinion at this time that it would be more cost-effective to upgrade the existing EMCS (Section 3.5.2) at 1/1Øth the cost of installing a new EMCS. The same energy saving benefits would be realized for either the upgraded or new EMCS. The upgraded EMCS, however, would <u>not</u> provide for two-way communication and, therefore, reports of operating status for all HVAC units. A new telephone communication line EMCS <u>should</u> be installed after the long range master plan has been implemented and when the upgraded EMCS has outlived its useful life (approximately 15 to 2Ø years from now).

The most cost-effective and easily implemented is the ECIP project to improve artificial lighting (Section 3.2.1). Although this project will require some disruption of the normal working routine as fixtures are replaced in interior spaces, energy savings should be realized immediately.

ECIP building envelope projects include improving ceiling and roof insulation with reflective roof coating and wall insulation (Sections 3.2.2 and 3.2.5). Implementation of these projects will significantly upgrade many semi-

permanent and permanent buildings that are presently showing signs of aging and have very poor thermal characteristics. By increasing the R-value of walls and roofs, occupants will be comfortable, less energy consumed, and maintenance reduced for HVAC equipment. In addition, building upgrading at this time will increase the useful life of those buildings that are scheduled to remain as part of the YPG Long Range Master Plan.

Installation of solar energy systems for domestic water heating (Section 3.2.4.) and other applications allows YPG to make use of its most abundant natural resource (solar energy) while satisfying Army guidelines of converting to renewable energy sources. The buildings selected as part of this ECIP project have large hot water demands, primarily for showers, cooking, clothes-washing, etc., and represent the most cost-effective application of solar energy.

The installation of nighttime setback thermostats (Section 3.2.3) for all family housing units is a cost-effective method of reducing the use of energy-inefficient electric resistance heating during that time of the day when occupant comfort will not be effected. The work can be done in short order, and energy savings can be realized immediately.

During the ECIP project program year (FY'86), YPG personnel should re-evaluate the status, condition, and operation of those buildngs recommended for improvement and make the necessary modifications to the project documentation that results from any changes that have occurred between FY'82 and FY'86.

4.3. INCREMENT G PROJECT RECOMMENDATIONS

All projects (or buildings within projects) that did not meet the ECIP criteria are documented as Increment G projects in Section 3.3. These projects did not meet ECIP criteria because they either did not provide sufficient energy and dollar savings to justify the initial cost and/or the initial cost for the work was less than $100,000.

Increment G projects include either:

1. Projects that are identical to ECIP projects documented in Section 3.2 but which include buildings <u>not</u> included in the ECIP project because they were not cost-effective and would have reduced the E/C ratio for the ECIP project below 13.

2. Original projects which did not meet ECIP criteria because of the reasons discussed above.

As mentioned in the previous section, the Increment G project to upgrade the existing EMCS (Section 3.5.2) should be implemented instead of the ECIP project to install a new EMCS (Section 3.5.3) because the upgrading provides the same energy savings at a reduced first cost. Most of the radio switches are already installed on the applicable buildings, and the overall logistics with regard to design and implementation are much more attractive for the EMCS upgrade.

With regard to movable insulation (Section 3.3.1.), the success of this project will depend on whether individual users open and close the insulating shades according to a reasonable schedule that was assumed to provide maximum energy savings (i.e., closed during summer days and winter nights, open during summer nights and winter days).

Family housing projects include adding exterior roof (Section 3.3.4) and wall (Section 3.3.8) insulation, and the installation of "breadbox" type solar domestic water heaters (Section 3.3.3). These projects are all useful. Together they will save a significant amount of energy (approximately 20,000 MMBTU/yr or 23% of the total family housing energy consumption). In reality, roof insulation would probably save even more energy than estimated, because in most housing units, the ducts are located above the ceiling flush against the uninsulated roof. This results in significant conduction losses from the ducts through the roof. The addition of roof insulation would help to minimize these losses and increase the energy savings which were not included in the calculations.

Family housing projects should be undertaken systematically during regular programmed maintenance of family housing walls and roofs.

All projects that involve upgrading the building envelope include:

- Weatherstripping (Section 3.3.2)
- Exterior wall insulation (Section 3.3.5)
- Exterior roof insulation (Section 3.3.9)
- Reflective roof coatings (Section 3.3.10)
- Wall insulation (blown-in) (Section 3.3.12)

These are all worthwhile projects even though none satisfied ECIP criteria. This work will reduce overall heating/cooling loads, improve the appearance of the housing, and extend the useful life of each building. These improvements should be considered in conjunction

with regular planned maintenance to walls and roofs, especially for permanent and semi-permanent buildings that will be actively used over the next twenty years.

Sunscreens for windows (Section 3.3.6), while not meeting ECIP criteria, still provide protection against summer solar heat gain and should be used wherever possible. Care should be taken so that sunscreens do not block out the diffuse sunlight that would otherwise enhance daylighting and therefore reduce the requirement for artificial lighting in offices and other work areas.

Improvement of lighting systems (Section 3.3.7) did not meet ECIP criteria for certain buildings because lighting usage and subsequent energy savings were too low to justify the initial cost of the retrofit. Many of the buildings that did not qualify are warehouses which are lit by many inefficient incandescent fixtures. A more appropriate low-cost maintenance type project for selected buildings would be to install translucent, corrugated fiberglass skylights in the roofs. This would permit turning off artificial lighting during the day. This item has been reviewed in Increment F.

Solar energy domestic water heating (Section 3.3.11) did not prove cost-effective for five of the buildings analyzed. However, YPG should consider allocation of funding for installation of a solar energy system for Building 120 which includes a number of relatively large hot water- using functions such as a laundry, beauty salon, and barber shop.

During each program year, FE personnel should re-evaluate the status, condition, and operation of those buildings recommended for improvement, and make the necessary modifications to the Increment G project documentation that results from any changes that may have occurred since FY'82 and the future project program year. In the future, any project that has a B/C ratio greater than 1, according to the ECIP guidelines, should be recommended for implementation.

4.4. INCREMENT F PROJECT RECOMMENDATIONS

This report outlines a wide range of improvements and practices for energy conservation, but if implemented correctly, could improve the operational efficiency of Facilities Engineering. The report is compiled in such a way as to facilitate separation and use of whole sections by persons for whom the information is most relevant.

The major thrust of Increment F is the development of "recommendations for modifications and changes in system operation which are within the Facilities Engineer

funding authority and management control". Increment F projects are summarized and prioritized by E/C ratio in Exhibit 3 and documented in Section 3.5. In addition, all Increment A, B, and G projects are summarized and prioritized in Exhibit 2.

Space Utilization, an issue that directly relates to energy consumption, is addressed in Section 4.0. In this section guidelines have been provided for facility planners to follow both for short and long range planning with the hope that this will result in additional energy savings.

Section 5.0 provides the Procurement Office and Facilities Engineering shops with information regarding energy-efficient expendable equipment. This information includes specifications concerning energy use for these items, names of manufacturers, model numbers of equipment, as well as manufacturers' cut sheets.

Information regarding continuing education and training for Facilities Engineering at YPG has also been identified and compiled in Section 6.0.

Predictions for energy use and costs over the next 20 years have been developed and presented in Section 7.0. These predictions include energy reductions from the implementation of Increment A, B, G, and F projects, energy reductions from the scheduled elimination of certain buildings, and the additional energy consumption associated with planned construction of new buildings.

Finally, Section 8.0 lists all the energy conservation steps taken by YPG since 1975.

4.5. ENERGY USE PROJECTIONS

The total energy savings that can be achieved from implementation of <u>all</u> recommended projects is simply the sum of the energy savings of each individual project, minus any overlaps that would occur between projects. The chart on the following page summarizes total energy savings.

Summary of Energy Savings

Sum of energy savings for all ECIP and Increment G projects	=	49,257
Reduction in total savings due to overlaps	=	2,516
Sum of energy savings for all Increment F projects	=	5,310
Subtotal	=	57,083 MMBTU/YR
Less Project Overlaps	=	5,030
Net Project Energy Savings	=	52,050 MMBTU/YR

The total energy reduction required to meet the 1985 Army energy conservation goals of 20% overall reduction in source KBTU per gross square foot floor area for buildings and family housing facilities would be approximately 55,600 MMBTU/YR. As the preceding chart indicates, the implementation of all recommended projects will provide 52,050 MMBTU/YR (or 94%) of the required energy reduction to meet 1985 energy goals. This suggests that further study is required in Increment C, for example, to identify additional energy conservation opportunities and thus meet or exceed the Army's energy conservation goal.

4.5.1. Energy Consumption for Future Construction

After review of the most recent FE Master Plan for new construction, revised May 1981, and the Construction Program Disposal Schedule dated 21 June 1982, a series of graphs and charts were prepared to estimate resultant annual energy demand, consumption, and costs over the next twenty years.

These projections also include energy reductions that will result from implementation of <u>all</u> energy conservation measures analyzed. This information is intended for use in energy planning and cost budgeting so that YPG will be aware of its increasing kilowatt demand and will be able to better accommodate it, both contractually with the various electrical utility companies and physically at the substation level.

The basewide energy consumption used in the budget projections is 338,200 "source" MMBTU's for FY '82. As shown in Exhibit 15, the projected annual energy consumption through 1990 including long range (LR) and non-appropriated funded (NAF) projects will increase this

Exhibit 15. ANNUAL ENERGY AND COST PROJECTIONS

FISCAL YEAR	ENERGY CONSUMPTION W/O ENERGY CONSERVATION PROJECTS (See Note 1)	ENERGY CONSUMPTION WITH ENERGY CONSERVATION PROJECTS (See Note 2)	PERCENT CHANGE (See Note 3)	ENERGY USE COSTS W/O ENERGY CONSERVATION PROJECTS (See Note 1)	ENERGY USE COSTS WITH ENERGY CONSERVATION PROJECTS (See Note 2)	PERCENT CHANGE (See Note 4)
82	338,200 MMBTU	338,200 MMBTU	-	$ 554,300	$ 554,300	-
83	336,011	332,703	+2	625,042	585,178	+5
84	336,011	325,017	+4	693,814	605,409	+9
85	335,666	317,986	-6	770,212	623,095	+12
86	344,794	306,876	-9	819,748	532,614	-4
87	351,239	307,019	-9	1,042,518	577,762	+4
88	349,277	298,755	-12	1,133,465	558,367	+1
89	394,212	343,690	+2	1,614,341	975,982	+76
90	419,013	368,491	+9	2,007,546	1,298,968	+134
LR	428,652	378,130	+12	4,501,598	3,733,075	+573
NAF	442,839	392,317	+16	4,384,962	3,598,439	+549

Note 1: Includes effect of long range construction plan.

Note 2: Includes: ECIP Projects, assumed implemented in FY'86
: Increment G Projects, energy savings over FY'85 - FY'88
: Increment F Projects, energy savings over FY'83 - FY'85

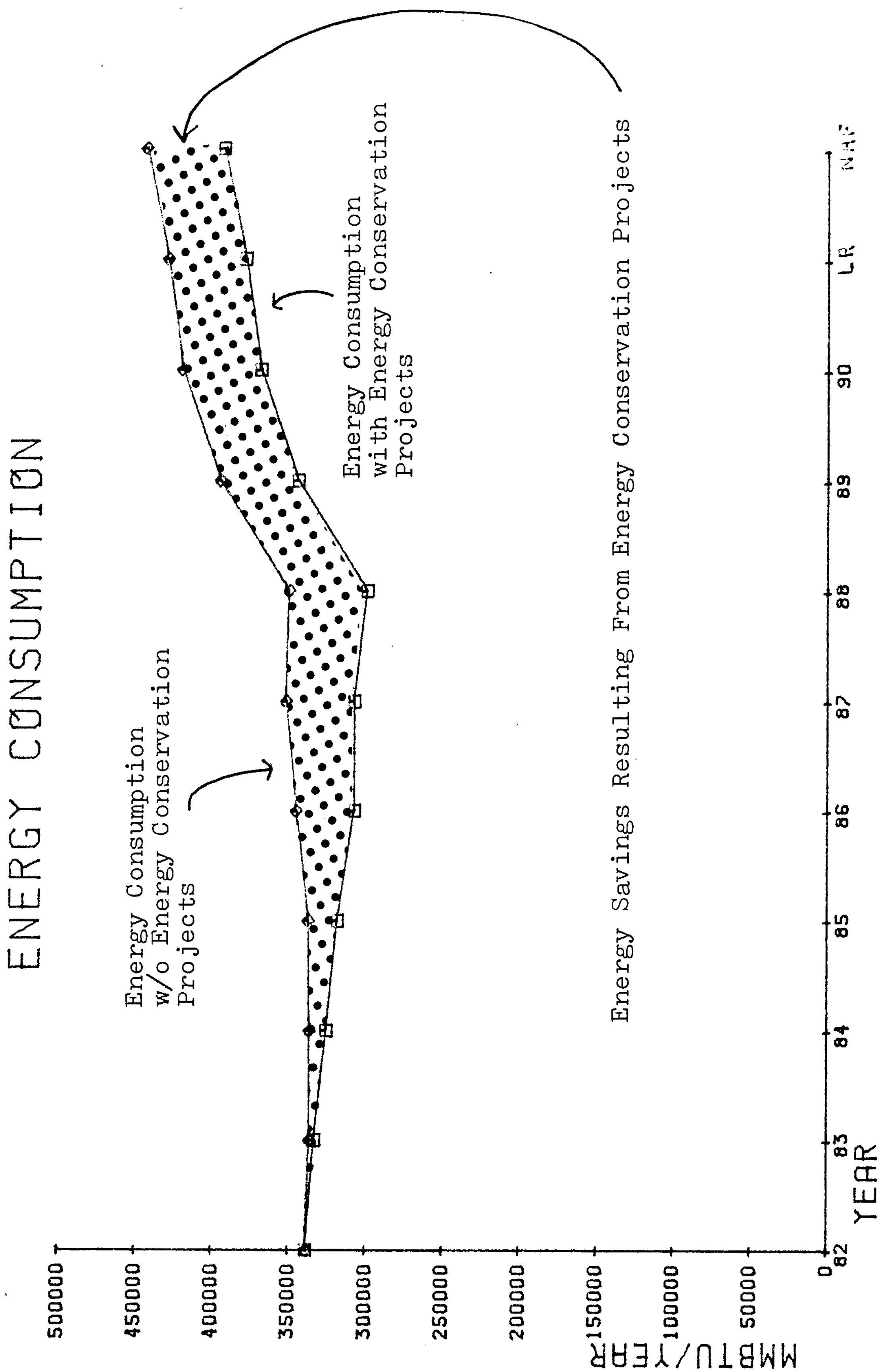
Note 3: Percent change is based on energy consumption with energy conservation projects using 1982 as the comparative year.

Note 4: Percent change is based on energy use costs with energy conservation projects using 1982 as the comparative year.

number by 16% to 392,317 MMBTU. These results are also presented graphically in Exhibits 16 and 17. The projections include energy consumption from new construction and energy credits resulting from the elimination of buildings that will be removed as well as the implementation of energy conserving projects. The energy budgets for new buildings (as shown in Exhibit 18) include boundary energy utilized within the buildings as well as source energy. It was assumed that all planned facilities will use electricity as the only energy source. Above and beyond the energy consumed for space heating, space cooling, domestic hot water heating and lighting there are significant process equipment loads. The necessary data and specifications to determine annual energy consumption for these operations was not available and as a standard evaluation technique, process loads were omitted from the long range energy budget.

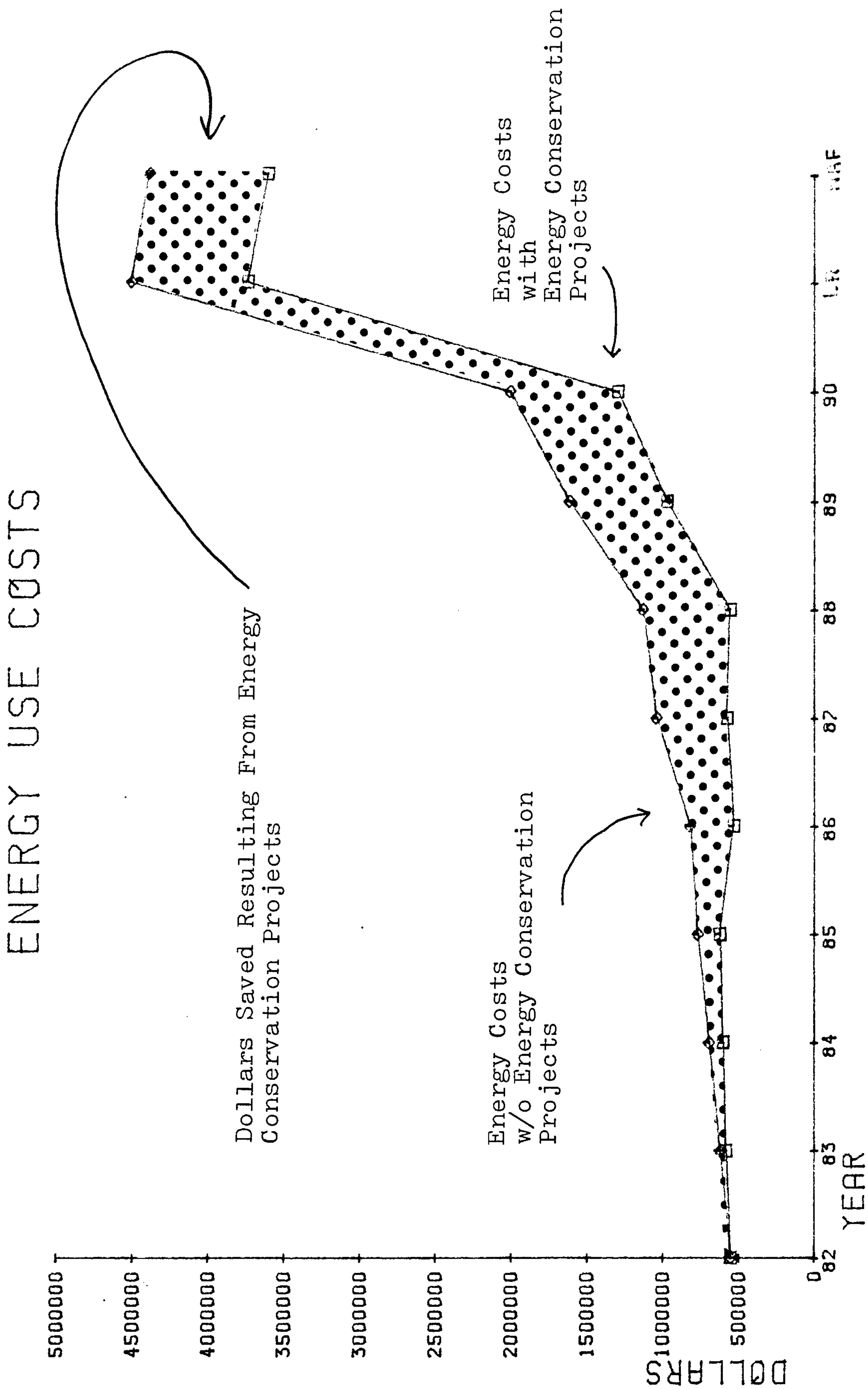
As a serious option for future energy planning at YPG, FE should consider the use of solar energy photovoltaic electrical power generating plants to provide large (250 KW) "blocks" of peak power. A project of this type is encouraged by recent congressional legislation, H.R. 6214. Such a projection would not only allow YPG to make use of their most abundant natural resource (solar energy), but if implemented in 250 KW blocks would also offset the costs of power purchased from the most expensive electrical utility company, saving enough money over the life of the equipment to make this type of project cost-effective, while providing a significant level of emergency power and energy self-sufficiency.

Exhibit 16. PREDICTED LONG RANGE ENERGY CONSUMPTION



LR (Long Range) and NAF (Non-appropriated Funds) represent the year 2002.

Exhibit 17. PREDICTED LONG RANGE ENERGY USE COSTS



LR (Long Range) and NAF (Non-appropriated Funds) represent the year 2002.

Exhibit 18. ENERGY USE PROJECTIONS FOR NEW CONSTRUCTION

Project Title	Project Number	Construction Year	Building GSF	Hours of Operation	Construction Category	Boundary Energy Budget (KBTU/sf/yr)	Site Electric Energy Budget (MMBTU)	Source Electric Energy Budget (MMBTU)
Dynamic Environmental Test Facility	117	81	12,258	0500-2000	310	50	612.9	2083.9
Guest House	T87600	83	7,550	0500-2000	710	40	302.0	1026.8
Skill Development Center	108	83	7,600	0700-1600	171	45	342.0	1162.8
Gymnasium	103	85	11,200	0700-1600	740	40	448.0	1523.2
Replace AMMO Storage Igloos	T85700	86	9,000		420	35	315.0	1071.0
Air Cargo Test Preparation Complex	T91800	86	37,625	0500-2000	310	50	1881.3	6396.4
Education Center and Library	65	86	10,375	0700-1600	171	45	466.9	1587.5
Aviations Facilities Improvements	T80700	87	12,611	0500-2000	210	80	1008.8	3430.0
Expand Radiographic Facility	T83300	87	13,245	0500-2000	310	50	622.3	2115.8
Religious Education Facility	120	87	2,000	0700-1600	730	40	80.0	272.0
ADP/Communications Center	T95100	87	22,000	0700-1600	130	45	990.0	3366.0
POL Storage and Dispensing Facility	T84700	88	5,200	0700-1600	410	35	182.0	618.8
Eastern KOFA Range Improvements	T88620	88	2,030	0500-2000	310	50	101.5	345.1
KOFA Motor Pool w/POL Facilities	T89200	89	500	0700-1600	210	80	40.0	136.0
Support Maintenance Shops	T84600	89	158,365	0700-1600	210	80	12669.2	43075.3
Multi-Purpose Ambient Piping Facility	T98000	89	1,990	0500-1600	390	50	99.5	338.3
Ballistic Measurement Building	T83200	89	3,200	0500-2000	310	50	160.0	544.0
Day Care Center	T94000	89	5,500	0700-1600	730-45	45	247.5	841.5
General Purpose Warehouse	T82100	90	153,800	0700-1600	410	35	5383.0	18302.2
Facilities Engineer Maintenance Shop	T94700	90	23,400	0700-1600	210	80	1872.0	6364.8

Exhibit 18. (cont'd)

Project Title	Project Number	Construction Year	Building GSF	Hours of Operation	Construction Category	Boundary Energy Budget (KBTU/sf/yr)	Site Electric Energy Budget (MMBTU)	Source Electric Energy Budget (MMBTU)
Tank Munitions (DU) Test Range	T87700	90	800		390	50	40.0	136.0
Printing and Publishing Plant	T90600	LR	5,400	0700-1600	690	45	243.0	826.2
Petroleum/Soils Analysis Evaluation Facility	T87200	LR	8,000	0700-1600	310	50	400.0	1360.0
Environmental Test Facility	T93200	LR	14,055	0500-2000	310	50	702.8	2389.5
Test Preparation and Munitions Security Facility	T93600	LR	6,000	0500-2000	310	50	300.0	1020.0
Meteorological Operations Building	T90400	LR	4,800	0500-2000	310	50	240.0	816.0
Climatic Effects Instrumentation Building	T86200	LR	500	0500-2000	310	50	25.0	85.0
Tank Armament Range Development	T93000	LR	18,449	0500-2000	310	50	922.5	3136.5
Controlled Environment Service Magazines	T85800	LR	4,375	0500-2000	310	50	218.8	743.9
Dispensary (Health Clinic)	T82600	LR	9,000	0700-1600	550	155	1395.0	4743.0
Post Headquarters Building	T80100	LR	37,800	0700-1600	610	45	1701.0	5783.4
Theater	T84500	LR	6,500	0700-1600	740	40	260.0	884.0
Commisary	T82710	NAF	17,280	0700-1600	740-21	80	1382.4	4700.2
Bowling Center	T82720	NAF	8,050	0700-1600	740	40	322.0	1094.8
Shopping Center	115	NAF	24,857	0700-1600	740-50	80	1988.6	6761.2
Officers Open Mess	T84100	NAF	12,000	0700-2000	740	40	480.0	1632.0
Sub-Total							11632.1	39550.8
Totals							38444.5	130713.1

5.Ø. **CONCLUSION**

5.1. GENERAL DISCUSSION

The successful completion of Increments A, B, G, and F of the basic EEAP for YPG results in a comprehensive database of energy use information and applicable projects designed to help meet the YPG energy conservation goals. It is strongly recommended that FE use this information which has been provided as reference for any additional energy related activities that may be planned. Additional verification of individual building loads and periodic updating of this information will insure that the database is kept up-to-date.

While the completion of Increments A, B, G, and F represents a significant effort toward the overall energy plan for YPG, it by no means represents a comprehensive plan to achieve maximum energy efficiency. Many other areas at YPG have been noted where additional energy can be saved. These areas were not pursued because they did not fall under the contract Scope of Work. It is anticipated that further projects identified in Increments C, D, and E studies will provide YPG with all the information necessary to achieve maximum energy efficiency

5.2. INCREMENT C PROJECTS

Increment C, which includes all renewable energy ECIP projects (principally solar) has direct application to YPG.

Yuma, Arizona, has an annual average percent possible sunshine of 91%, making it one of the most consistently clear and sunny areas in the United States. If solar energy is going to be effective anywhere, it will be effective in Yuma. In fact, solar energy will probably prove to be the most cost-effective method for exceeding the long range energy goals and reducing overall building energy consumption by more than 2Ø% by 1985.

Applications range from domestic hot water and space heating to space cooling and perhaps a central solar energy cogeneration plant to produce electricity and thermal energy for the entire base. The state-of-the-art of solar energy technology is such that all of these applications can be satisfied in an efficient and cost-effective manner.

YPG should develop a realistic plan for the basewide use of solar energy. This EEAP has identified various solar energy system (SES) projects as either ECIP or Increment G projects:

- ECIP project to install SES for DHW in 7 buildings

- Increment G projects to install SES for DHW in 5 additional buildings

- Increment G project to install "breadbox" type SES in 289 family housing units to provide DHW

The next most obvious application would be to provide solar energy space heating for selected buildings at YPG. This could be accomplished in many ways, depending on the building type, existing HVAC system design, and present energy requirements. In general, the design of space heating systems will fall into one of two categories:

- 24 hour/day space heating requirement and

- 8 - 10 hour/day space heating requirement

The first category (which includes, for example, barracks) has a much greater total basic heating load, since the requirement for space heating is at night. On the other hand, the second category (which includes, for example, offices) has a higher "pick-up load" in the morning before the occupants arrive. Both require careful design of collection, storage, and control subsystems.

Space cooling with solar-assisted absorption chillers was included in the original design of the ROC Building 2105. However, this particular system has had many problems from the beginning which require continual attention. EMC proposes to sort through these problems as we have done successfully for other existing large systems. During Increments C, a plan will be proposed for correcting these problems. Our extensive experience with a number of such systems suggests that there may be a need for upgrading the controls and the method in which the system is operated. Certain mechanical system changes may also be required.

The ultimate use of solar energy would be the construction of photovoltaic arrays to generate electrical power and reduce peak demand and consumption. The photovoltaic industry has made significant breakthroughs over the past few years in this area.

There are a number of recent examples which are useful analogies. Very preliminary analysis shows that at $2.00 per peak watt, an investment of approximately 14 million dollars could save approximately 200,000 MMBTU/year of electricity (or 60%) at an E/C ratio of 14! The solar

industry goal of producing electricity at $1 per peak installed watt within the next 10 years is indeed a possibility. By aggregating a large market for solar at YPG, the government could also help to make photovoltaics more affordable to the private market.

There are abundant opportunities for using solar energy at YPG. EMC is anxiously looking forward to this useful work and will investigate all of the many possibilities, including those for mission-related activities (range testing, etc.). We fully expect that solar energy will play a significant role in the energy future of YPG!

5.3. MAINTENANCE

As is the case in any large facility, maintenance of equipment plays a significant role in the efficient operation and longevity of all building-related operations. YPG is no exception to the rule.

During field trips to YPG, we observed various maintenance-related activities and procedures. In general, it appears that the YPG maintenance staff performs good annual preventative and scheduled maintenance for most building-related systems.

There are, however, a number of problems which the maintenance department has experienced. These can be summarized as follows:

1. All the buildings and HVAC equipment within buildings are assigned to maintenance personnel who are responsible for cards that identify each piece of equipment and the various maintenance procedures for the equipment. In general, these cards and their format are outdated. The information needed is inconsistent with their format. The result is that there is no accurate and up-to-date list of equipment size, capacity, manufacturers' data or maintenance records. We recommend that this entire system be upgraded by using a micro-computer to store and update all the information mentioned above. This will provide more efficient and up-to-date equipment records, improve preventive maintenance procedures, reduce equipment down time, and facilitate more effective equipment procurement.

2. While there is an annual preventive maintenance program in effect at YPG, it became obvious that local controls; i.e., thermostats, outside air dampers, etc., remain in poor condition and are not regularly upgraded. This is a wasteful situation. It is anticipated that much of the

information needed to correct this problem will be provided through the Increment F document.

3. Experienced personnel in the maintenance department (especially those who have been at YPG for 1Ø - 2Ø years) know more about how to save energy than most other people at YPG, simply because they are more familiar with energy-consuming equipment. However, when they have reported energy waste or have come up with ideas to reduce it, not many people pay attention to them. As a result, these maintenance "veterans" are no longer motivated to search and correct instances of energy waste. To correct this situation, an incentive program has been established whereby employees will be awarded for ideas which save energy.

Most of the principal administrative buildings at YPG are of semi-permanent construction. For these buildings to remain useful until permanent buildings are provided, a number of maintenance and repair projects should be initiated to correct various deficiencies. Some of this work is already in progress. The more serious problems requiring attention are termite damage, leaking roofs, deteriorated window frames, deteriorating insulation in the exterior walls, and worn-out air conditioning systems.

5.4. METERING

"Missing Load"

Although sub-metering will not save energy by itself, it will provide important information about building energy consumption, non-building energy consumption, and the unknown, "missing load" which has been identified at YPG.

With the existing metering plan; i.e., sub-metering at each substation, and the energy use information provided in this report, YPG personnel can track energy use for the 5 main areas served by the various sub-stations. This will allow for the identification of fluctuations from the "average" energy consumption rate and could pinpoint the fluctuation to a specific area or group of buildings. In particular, it could track large energy consuming mission testing operations and possibly the missing load.

Illegal Tap?

Sub-metering should be considered for many of the large energy consuming buildings at YPG, such as 5Ø6, 349Ø, 6Ø71, 1ØØ4, and 1Ø5. In addition, mission testing (including the environmental test chambers and laser operations) should be sub-metered to get a more precise measurement of the actual mission-related energy consumption.

There should be more coordination between FE and the personnel involved with mission testing. In particular, FE should set up a schedule of hours during which it would be more desirable for high electrical usage mission testing to occur, the purpose of this being to minimize, if possible, electrical demand during critical periods of time.

Energy use by family housing units should continue to be scrutinized. Meters on each of the 289 family housing units show us that energy use in the family housing section amounts to 255 KBTU/GSF-yr or approximately 35% above the average basewide energy use for all buildings. The average 1100 SF residence consumes about 2100 KWH/month over the year, and, in isolated cases, has been known to exceed 5000 KWH/month during the summer. Data from Arizona Public Service indicates that most existing single family residences in Yuma use on the average 1500 KWH/month and 2500 KWH/month during the summer. A new energy conserving house should not use more than 800 KWH/month. These numbers suggest that there is considerable room for improvement.

With regard to fuel oil and propane energy use, these fuels should be sub-metered at regular intervals. For example, in addition to metering fossil fuel deliveries to buildings (which occur on an irregular basis), every fossil fuel consuming building should be metered monthly to determine the amount of fuel consumed during the previous month. This information should be charted and graphed for each building to enable one to identify any significant irregularities in patterns of energy use.

It is only through a comprehensive metering plan that YPG will discover areas of large or unknown energy use, pinpoint maintenance problems that need to be corrected, and implement energy projects that will result in considerable energy savings over time.

5.5. ENERGY AWARENESS

Energy awareness, on the part of facility engineers who maintain the buildings, civilian personnel who work in them, and military personnel and their dependents who live in them is probably the second most important ingredient for a successful energy conservation program at YPG. Buildings don't use energy, people do. It is the human element which eventually determines how much energy is consumed or conserved. The importance of energy conservation not only as an economic but also as a political consideration cannot be ignored. Our future self-sufficiency and independence from imported oil will depend on our ability to conserve energy.

The people at YPG should be encouraged to participate in an energy awareness program in an attempt to peak their interest and desire to conserve energy. YPG has already suggested or implemented various programs to provide this sort of energy awareness. These include:

- Energy Building Temperature Restrictions
- Mock Fuel Billing
- Commander's Walk-thru Program
- Employee Energy Awareness Information Program
- Energy Conservation Awareness Week
- Energy Films
- Suggestion Program
- Energy Awards

These are all very worthwhile programs. In addition to, or as part of the above, the following additional suggestions are also recommended to further motivate interest in energy conservation:

1. Alternative Energy Workshop. These are designed to teach persons interested in the fundamentals of solar energy, and to actually build a small solar energy system on one or more buildings at YPG.

2. YPG Energy Awareness Program. A series of short seminars should be designed to cover a variety of topics:

   a. Energy Consumption at YPG: Where It All Goes, and How It Can Be Reduced. A slide presentation could be developed around much of the material contained in this report.

   b. Energy Consumption In Family Housing Units: Where It All Goes, and How It Can Be Reduced.

   c. Energy Consumption In The Workplace: Where It All Goes, and How It Can Be Reduced.

3. A volunteer force of men, women, and children could patrol YPG and report instances of energy waste. A monthly award or prize could be given to those who report significant areas of waste.

5.6. ENERGY PLANNING

It is much easier to make buildings energy-efficient by designing them before they are built to use less energy.

Energy performance levels for all space use types of new construction need to be established. Numbers do exist in military standards but these are not sensitive to the requirements at Yuma nor are they disaggregated by function. Improved standards will serve several useful purposes. By implementing future plans for new buildngs to replace older ones, YPG could be sure that more energy will be saved than would be otherwise by simply making improvements to existing buildings. Requirements for energy-efficient design should be built into the scope of work statements of all A/E contracts. By expediting plans for new construction it may be possible, for example, to achieve greater reductions in energy use more cost-effectively than by implementing recommended projects for existing buildings. A timely combination of retrofit projects and energy-efficient new construction would surely exceed the 1985 goals.

It is essential, however, when establishing energy performance standards for new construction and in requiring A/E firms to satisfy these objectives, that a procedure be developed in which a competent third party reviews work by the A/E to make certain that the required level of performance is satisfied. Also, during construction, it is important to see that design features which are essential to achieve expected levels of energy peformance are included. Finally, after the buildings have been occupied, each should be submetered so that actual energy use can be compared with predicted values. Thus, findings from an analysis of deviations between projected and actual energy use can be used thereafter to establish better standards, improved building operating and maintenance procedures, and/or changes to statements of work in future A/E contracts.